STANFORD RESEARCH INSTITUTE

MENLO PARK, CALIFORNIA

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Instruction Manual

OPERATING AND MAINTENANCE INSTRUCTIONS FOR STANFORD RESEARCH INSTITUTE GRID MIXER

Prepared for:

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I INTRODUCTION

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The Stanford Research Institute Grid Mixer accepts a video signal representing a cloud picture, and upon command inserts grid points, and then delivers the signal otherwise unchanged. This function is performed for three channels of Nimbus AVCS information and one channel of HRIR information. The equipment is contained in one standard rack along with sufficient test equipment to perform maintenance and alignment (see Fig. 1). Specifically, the rack contains the following:

4 AVCS gridding units

2 HRIR gridding units

1 Tektronix 535 scope

1 Hewlett-Packard 200 CDR oscillator

1 Hewlett-Packard counter

1 Demodulator and patch panel.

The spare AVCS and HRIR gridding unit can be switched to an operating channel by changing the position of a plug on the front of the demodulator and patch panel. If a gridding unit fails, the spare unit can be immediately switched to that operating channel and maintenance can be performed on the failed unit without system down-time. The units are self contained; they have separate power supplies and provisions for video and grid inputs and outputs so that bench maintenance can be performed.

author

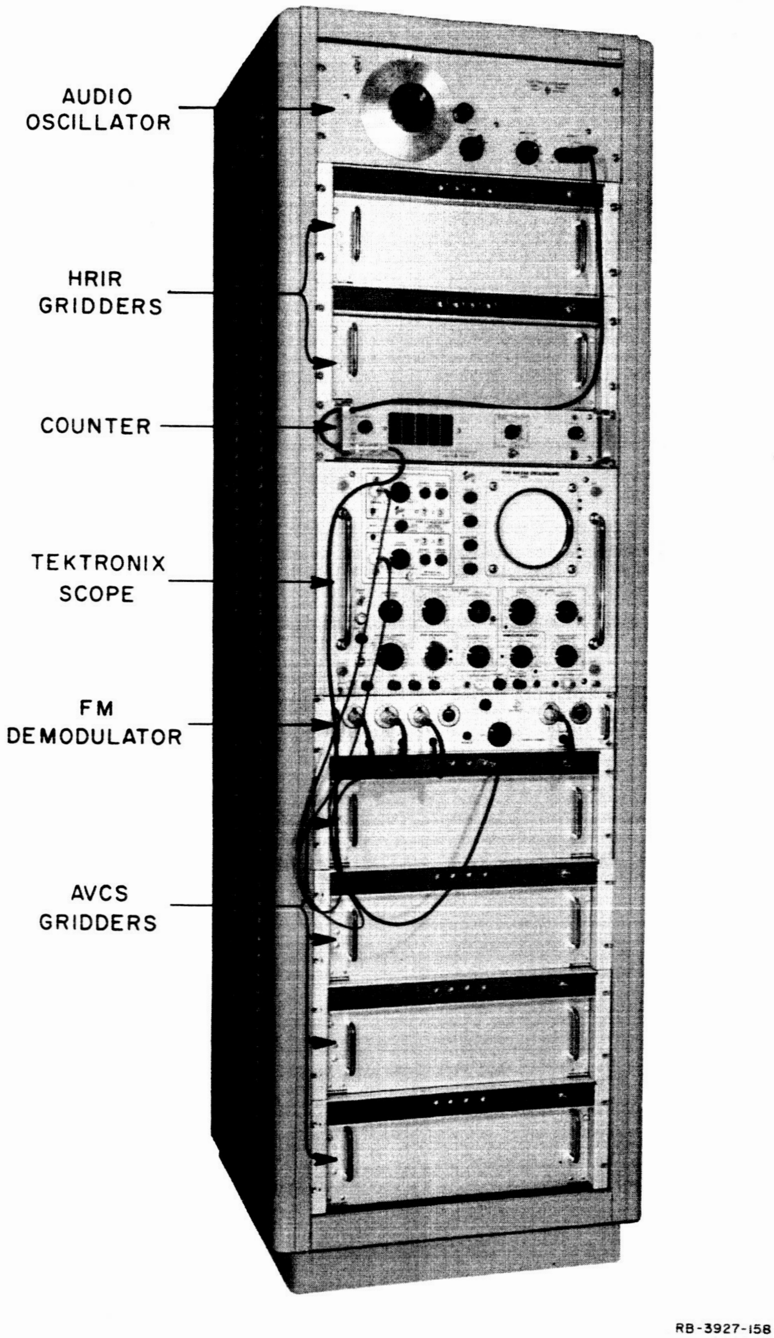


FIG. 1 THE SRI GRID MIXER

II GENERAL DESCRIPTION

Both the AVCS and HRIR gridders accept an FM video signal, heterodyne this signal to a higher frequency with an oscillator whose frequency can be controlled, then heterodyne the signal down in frequency with a crystal-controlled oscillator and deliver the signal to the output. In areas of the cloud picture where no grid points are present, the first (controlled) oscillator frequency is made to be equal to the crystal oscillator frequency. Under these conditions the output of the gridder resembles the input in all respects, including whatever amplitude modulation the FM signal may have. When a grid pulse input is received, the first oscillator frequency is varied in such a fashion as to cause the output frequency to shift first to the frequency corresponding to white, then to the frequency corresponding to black. Following this, the frequency of the first oscillator is returned to the crystal oscillator frequency. The amount of time the controlled oscillator spends at the black and white frequencies is adjustable. This means that the physical size of the grid points on a picture are adjustable. Both the black and white portions of a grid point may be varied from about two to five picture elements.

Figures 2 and 3 show block diagrams for the AVCS and HRIR gridding units. In the AVCS FM video signal the frequency corresponding to white is 29.4 kc; the black frequency is 21.0 kc. The input signal is first phase split and delivered to a balanced mixer. Under quiescent conditions the controlled oscillator frequency is the same as the crystal oscillator frequency—190.0 kc. The mixer output has white at 219.4 kc and black at 211 kc. The controlled oscillator frequency is held at 190 kc by a servo loop comprising Discriminator I and a low-pass RC filter.

The output of the balanced mixer is filtered by a stagger-tuned triple followed by a high-pass LC filter. This signal is fed to a single-ended mixer where it is heterodyned down in frequency by the crystal oscillator. The signal is now band-pass filtered and amplified.

The presence of a grid point command initiates a routine whereby the control of the first oscillator is shifted to a second discriminator for a fixed period of time (2 to 5 picture elements). This discriminator

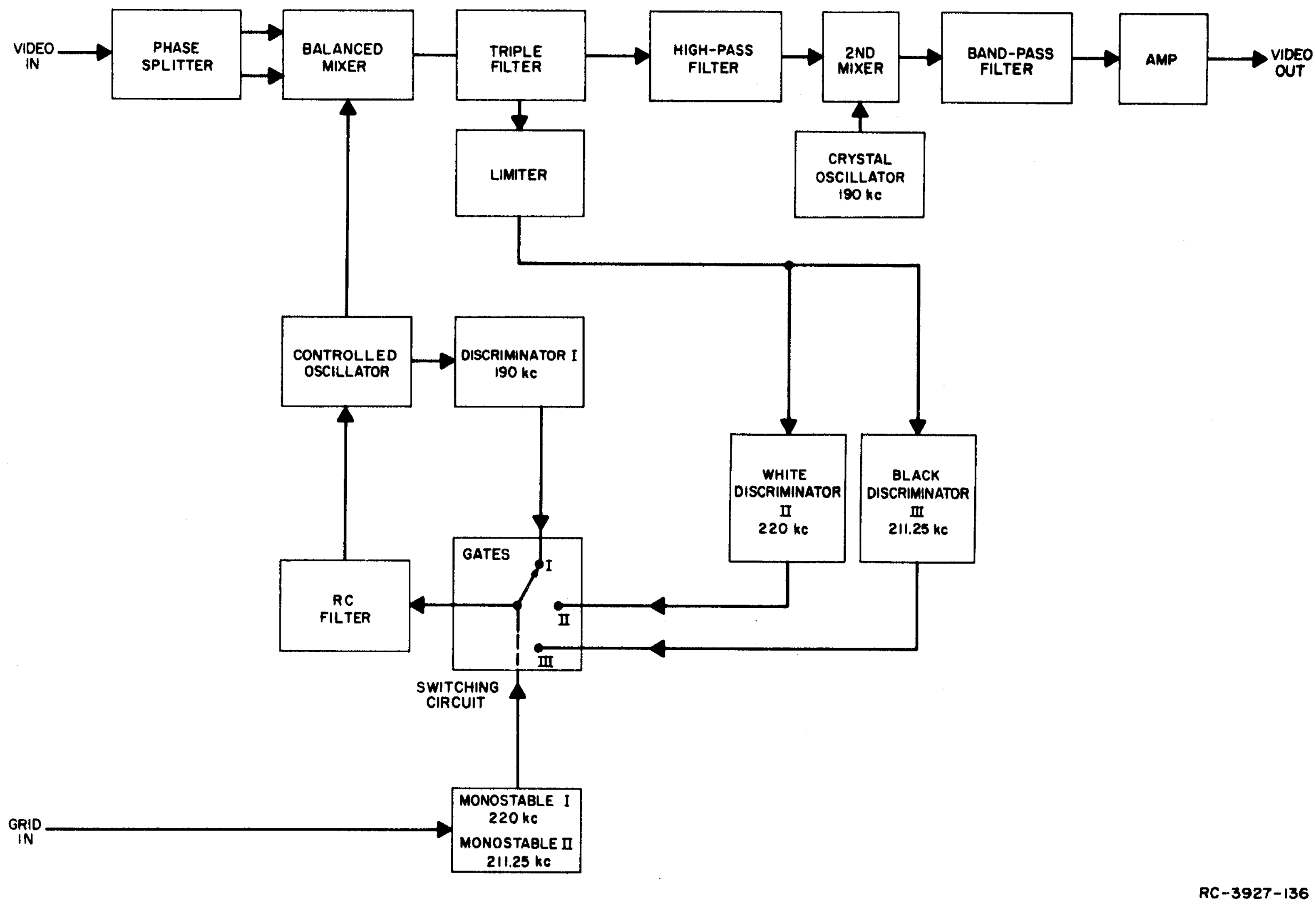


FIG. 2 AVCS GRID-POINT MIXER BLOCK DIAGRAM ACCORDING TO FUNCTION

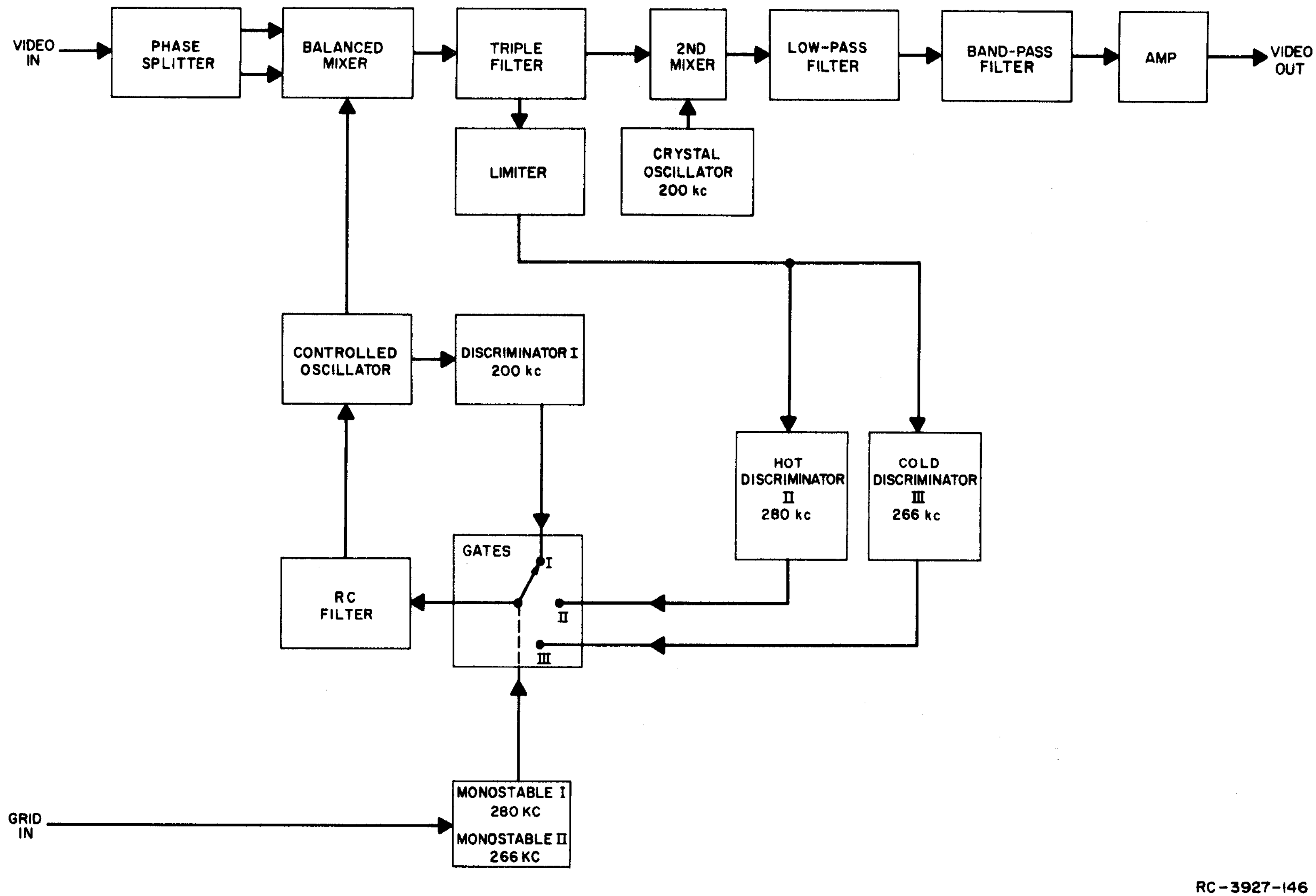


FIG. 3 HRIR GRID-POINT MIXER BLOCK DIAGRAM ACCORDING TO FUNCTION

forces the output frequency to be at 29.4 kc (the white frequency). Then the control is transferred to a third discriminator where the output is forced to be at 21.0 kc (the black frequency) for a period of time from 2 to 5 picture elements. Then the control is returned to the first discriminator, the first oscillator frequency equals the crystal oscillator frequency, and the quiescent mode of operation is restored.

The operation of the HRIR gridder is similar to AVCS except for some small differences in filtering. The HRIR signal deviation is from 66.0 to 80.0 kc. with white (representing high temperature) at 80.0 kc and black (representing low temperature) at 66.0 kc. The crystal frequency is 200.0 kc.

III DETAILED TECHNICAL DESCRIPTION

A. "HETERODYNING-UP" OPERATION (Card 5)

In both the AVCS and HRIR unit the input signal goes to Card 5 where it is heterodyned up in frequency. (Schematic diagrams of all cards are given in Appendices C and D.) The signal first goes to a phase splitter. The balanced signals drive the bases of the balanced mixer, with the square-wave signal from the controlled oscillator (astable multivibrator) driving the emitters. The mixer output signal is developed across the collectors of the balanced mixer. From the mixer output, the signal is transformer-coupled to a three-stage amplifier using three tuned circuits which form a staggered triple. The triple is tuned to pass the upper sideband of the mixer output and to attenuate the lower sideband.

B. "HETERODYNING-DOWN" OPERATION (AVCS Cards 6, 7, and 8)

The output of the triple goes to a high-pass filter on Card 8 where the lower sideband is further attenuated. The signal then goes to Card 6, where it drives the base of the unbalanced second mixer. The signal for the emitter of this mixer is provided by a crystal oscillator isolated by an emitter-follower buffer. The low-frequency output is developed at the collector of the second mixer and drives the band-pass filter, which passes 13.75 kc to 35.0 kc. This filter passes the desired signal while attenuating the low-frequency output due to oscillator unbalance and the output due to the high frequency signals coupled into the second mixer. The output of the band-pass filter is coupled to a three-stage amplifier in Card 8 where the signal is brought up to the desired one-volt level across 75 ohms. The high-frequency components from the output of the second mixer are further attenuated by the low-pass constant-*k* filter in the collector of the first stage, and by the $0.033\text{-}\mu f$ capacitor across the 75-ohm output. A switch is provided to terminate the output for test purposes when it is not connected to the succeeding line amplifiers where it is normally terminated.

C. CONTROLLED OSCILLATOR (Card 4)

The controlled oscillator is an RC astable multivibrator whose square-wave frequency is controlled by varying the voltage applied to the base resistors. The square-wave voltage on one side of the multivibrator is used to drive the first mixer through an emitter follower. The square-wave voltage on the other side supplies the input for Discriminator I, which operates in the absence of grid pulses to keep the controlled oscillator at the correct frequency. The oscillator control voltage, which is derived from switching between the outputs of the three discriminators, is first put through an RC filter network, and then applied to the oscillator base resistors through an emitter follower.

D. DISCRIMINATORS AND LIMITER (Cards 3 and 4)

Each discriminator consists of two series-tuned circuits driven by an emitter follower, one tuned above and the other below the desired frequency. Two diodes rectify the output of the tuned circuits, providing positive voltage on the lower frequency and negative voltage on the higher frequency. These are resistively added and applied to an emitter follower which provides one of the inputs to the switching circuits.

Discriminators II and III are tuned to the white and black frequencies, respectively. These are 190 kc, the oscillator frequency, plus 29.4 kc, the white frequency, and 21.0 kc, the black frequency, forming 219.4 kc and 211.0 kc. The two tuned circuits in the white discriminator (labeled Discriminator II, in Fig. 2) are tuned to 208 and 238 kc, while the two tuned circuits in the black discriminator (labeled Discriminator III, in Fig. 2) are tuned to 200 kc and 230 kc. Each of these discriminators is supplied by the output of the staggered triple amplifier which first drives a limiter circuit that clips the signal so that the loop gain will not be amplitude-sensitive. The clipped square wave forms the input of the two emitter followers driving these discriminators.

In the absence of grid points, the switching circuit connects the oscillator control signal to the output of Discriminator I, which serves to keep the controlled oscillator at its normal frequency of 190 kc. The discriminator is similar to the other two described, having tuning frequencies of 175 kc and 205 kc, to provide a center frequency of 190 kc.

E. DISCRIMINATOR SWITCHING (Cards 1 and 2)

Three identical 5-diode analog gates, located on Card 2, are employed to transfer control of the first oscillator between the three discriminators. The outputs of the three gates are all connected together while the inputs are respectively connected to the three discriminators. The control circuitry is so arranged that only one of the gates may be conducting at any one instant.

The control circuitry consists primarily of two cascaded emitter-coupled monostable multivibrators located on Card 1. The first monostable is triggered by the negative-going input grid pulse (Test Point C) which turns on a normally off transistor. The recovery time of the first monostable is adjustable by varying the setting of the 50-kilohm potentiometer "First Monostable Width." The second monostable is triggered, in turn, upon recovery of the first by means of a 680-$\mu\mu$f capacitor coupled to the base of the normally off transistor. The first monostable is prevented from firing again until the second monostable has recovered by means of an 18-kilohm feedback resistor coupled to the input base of the first monostable. The recovery time of the second monostable is adjustable by varying the setting of the 50-kilohm potentiometer "Second Monostable Width."

Three signals to control the three analog gates are derived from these two monostables and appear on Pins 8, 9, and 10 of Card 1. Each analog gate is disconnected if its control signal is less than plus ten volts, and connected if the control signal is greater than ten volts. The control signal for the normally conducting gate (used for switching Discriminator I) is derived from the outputs of both monostables through two 33-kilohm resistors. If either monostable is firing, then the first gate is disconnected. The control signal for the second gate (used for switching Discriminator II) is obtained from the first monostable using an NPN transistor for inversion so that the second gate is connected only when the first monostable is firing. The control signal for the third gate (used for switching Discriminator III) is similarly obtained from the second monostable, allowing the third gate to be connected only when the second monostable is firing. In this manner the control of the oscillator on Card 4 is transferred from Discriminator I, upon receipt of a grid pulse, first to Discriminator II, then to Discriminator III, and finally back to Discriminator I.

In order to provide a smooth transition in output frequency between the black and white frequencies without excessive overshoot, the common output of the three gates is partially limited by a parallel combination of two diode-resistor series circuits. (This network serves to limit the loop gain when the instantaneous signal frequency and the discriminator frequency are widely different, while maintaining a high loop gain near the null).

F. DETAILED TECHNICAL DESCRIPTION OF HRIR GRIDDER

Since HRIR is functionally identical to AVCS, only the differences in details will be covered here. The oscillator frequency for HRIR is 200 kc, with the 66- to 80-kc input signal heterodyned up to 266 to 280 kc. As in AVCS the signal goes first to Card 5 where it is heterodyned up, using a balanced mixer, and then amplified in a staggered triple. The high frequency signal then goes to Card 6 where it feeds the base of the second mixer, whose emitter is driven by the same crystal-oscillator-emitter-follower combination.

The two systems differ considerably in the mixer output circuits, in that conventional components, rather than potted custom filters, are used to form the correct filtering characteristics. A constant-*k* low-pass filter is used in the collector of the mixer to attenuate the oscillator signal and its harmonics. An emitter trap is used to further attenuate the 200-kc oscillator frequency. In addition, a band-pass system from 66 to 80 kc is used consisting of a double-tuned circuit using low side capacitive coupling, and a broad-band single-tuned circuit across the output termination.

To provide "cold" and "hot" points at 66 kc and 80 kc, respectively, Discriminators II and III are tuned to 266 kc and 280 kc. The 266 kc is established using tuning frequencies of 248 kc and 288 kc, while the 280-kc is established using 262 kc and 302 kc. Discriminator I uses tuning frequencies of 180 kc and 220 kc to provide a 200-kc center frequency. The only other differences between HRIR and AVCS are in the sizes of the monostable time constants on Card 1, since the HRIR grid pulses are wider than that of AVCS.

G. TEST DEMODULATOR

The FM demodulator included in the switching panel of the rack is a self-contained unit designed to be used for alignment and maintenance purposes. Figure 4 shows a schematic diagram of this unit. Depending upon the position of the input rotary switch the demodulator operates with either the AVCS frequencies of 18 to 30 kc or the HRIR frequencies of 66 to 80 kc. The input amplitude of the FM signal may vary from 0.5 to 2.0 volts PP (0.18 to 0.71 volts rms). The output signal is dc coupled, varying from approximately minus twelve volts to ground. Two twenty-volt power supplies are used, supplying the plus and minus 20-volt busses. A single transistor is used to regulate an additional minus-twelve-volt bus from the negative supply.

The demodulator operates on a cycle-to-cycle basis with no storage; that is, each cycle of the input FM signal is treated separately. The output of the demodulator (before a simple RC filter) is a stairstep wave-form, the dc level of each step representing the reciprocal of the time between zero crossings of the input signal. In this manner the variations in dc levels of the stairsteps are linearly related to the cycle-by-cycle frequency variations at the input.

During one cycle of the input signal the sequence of operations in the demodulator is as follows: The positive-going zero crossing of the input signal causes a 2200-$\mu\mu$f capacitor to be clamped to a −12 volt level for a fixed length of time, slightly shorter than half the period of the highest instantaneous frequency of the band. Then the capacitor is allowed to charge exponentially toward ground until the negative-going zero crossing occurs. At this instant the charging current is stopped, and the voltage level attained by the capacitor is transferred through a six-diode gate to a 3900-$\mu\mu$f capacitor and thence through two cascaded emitter followers to the output. The next positive-going zero crossing causes the diode gate to be disconnected so that the voltage on the 3900-$\mu\mu$f capacitor continues to be transmitted to the output while the 2200-$\mu\mu$f capacitor is being charged once again.

Tracing the operation of the circuit it may be seen that the signal is first limited to the range ±0.6 volts by two silicon diodes (DI-56). This signal is then amplified and limited in three stages, the first being a conventional single transistor amplifier, while the second and third stages are arranged as difference amplifiers. The signals appearing on the collectors of the third stage are essentially square-wave signals out of phase. The six-diode gate is driven by two emitter followers from the two square waves. In addition, one of the emitter followers drives

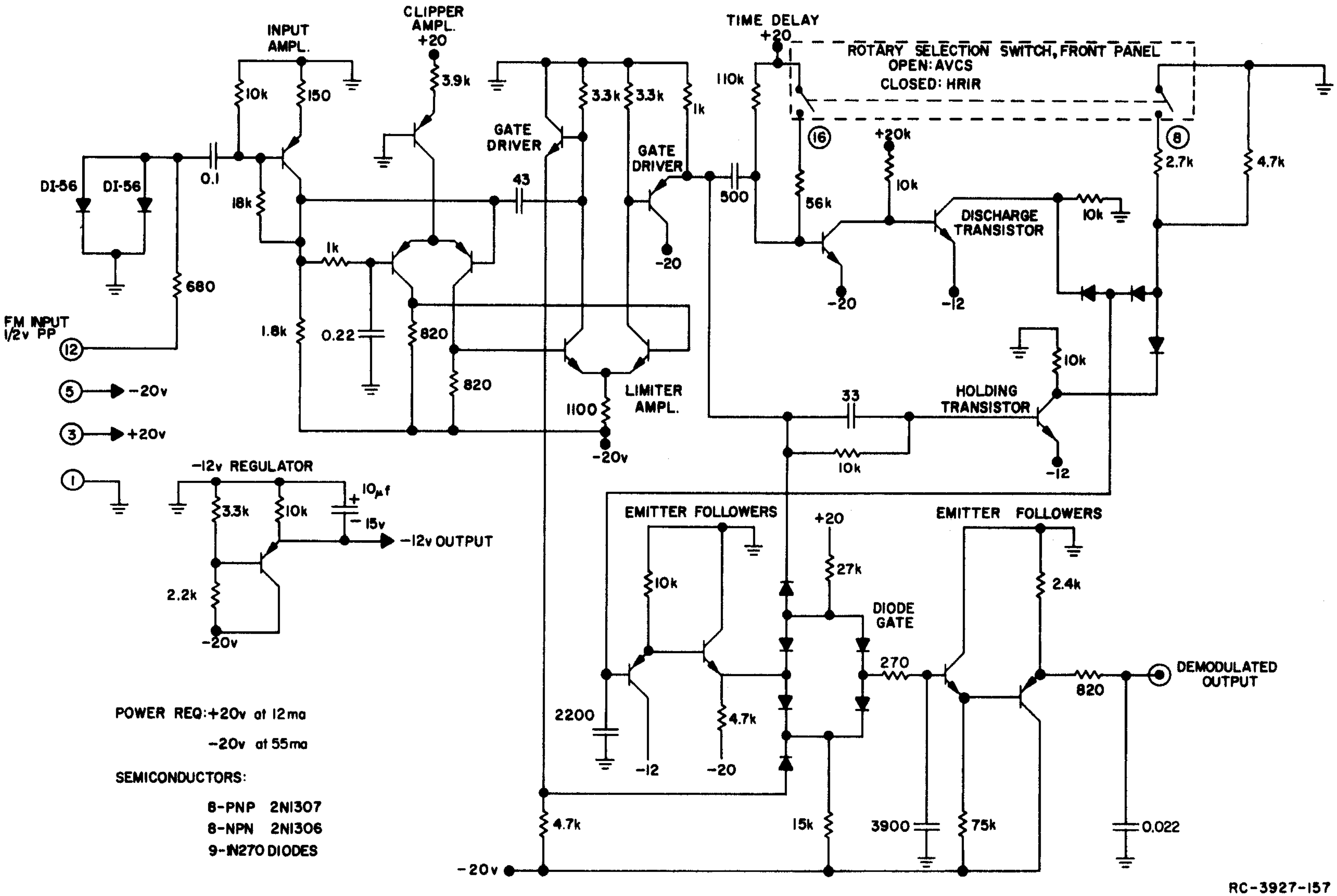


FIG. 4 FM DEMODULATOR
AVCS: 20-30 kc
HRIR: 60-80 kc

both the time delay circuit and the holding transistor. The necessary time delay is obtained by coupling the negative-going edge of the square wave through a 500-$\mu\mu$f capacitor to the base of the NPN time delay transistor, cutting it off until the 500-$\mu\mu$f capacitor has time to recharge through the 110-kilohm resistor. (In the HRIR mode the 110-kilohm resistor is shunted by a 56-kilohm to decrease the time delay.) Cutting off the time delay transistor causes the discharge transistor to be turned on so that the 2200-$\mu\mu$f capacitor is clamped to minus twelve volts. At the end of the time-delay period the discharge transistor becomes cut off, allowing the 2200-$\mu\mu$f capacitor to charge toward ground through a diode and a 4.7-kilohm resistor. (In the HRIR mode, the 4.7-kilohm resistor is shunted by a 2.7-kilohm resistor to provide a faster charging rate.) This charging continues until the positive-going edge of the square wave occurs, at which time the holding transistor is turned on, disconnecting the charging current. At the same time, the six-diode gate is turned on, allowing the voltage level attained by the 2200-$\mu\mu$f capacitor to be transferred to the 3900-$\mu\mu$f storage capacitor through the two cascaded emitter followers. The gate remains shorted for one half a cycle of the input signal, becoming disconnected during the other half cycle.

IV ALIGNMENT INSTRUCTIONS FOR AVCS AND HRIR

The four general areas of alignment are oscillator frequency, black and white frequencies, output level, and grid point widths. Items that are unlikely to need alignment during prolonged operational use except for component changes are oscillator balance on AVCS, and tuning frequencies of the staggered triple amplifier, and other filters.

A. OSCILLATOR FREQUENCY

In the initial set up, the test oscillator output is plugged into the jack labeled "DISC I INSERT," with the oscilloscope looking at Test Point D on Card 4. Using the counter, the frequency of test signal is set at 175 kc and 205 kc for AVCS, and 180 kc and 220 kc for HRIR, with the associated coils tuned to provide a maximum and minimum reading, respectively, as indicated on the oscilloscope. It is important in this and all other discriminator tuning to maximize and minimize the average dc value and ignore the unfiltered signals riding on the dc level. This initial discriminator set-up represents the coarse adjustment and should not require readjustment during the course of prolonged normal usage.

For the fine adjustments, the beat between the controlled oscillator and the crystal oscillator is observed by algebraically adding them in the oscilloscope using Test Point B on Cards 4 and 6. No grid signals are used in this adjustment. To adjust the free-running oscillator frequency, a bare plug is inserted in "DISC I INSERT" and the oscillator control voltage pot on Card 4 is adjusted for the lowest frequency beat. Following this, the loop is restored by removing the plug. The final adjustment for zero beat consists of touching up either one of the two discriminator coils previously aligned, for a zero beat. These coils represent the vernier adjustment that can be touched up from time to time, to insure that the input and output frequencies of the gridder are very close.

B. BLACK AND WHITE FREQUENCY ADJUSTMENT

The coarse adjustment of the black and white (and hot and cold) frequencies is made by tuning the discriminator coils using the test oscillator plugged into the "limited Insert" jack and the oscilloscope observing

Test Points A and then D on Card 3. The frequency of the test oscillator is adjusted using the counter. *In each discriminator the lower-frequency coil is tuned for maximum output and the higher-frequency coil is tuned for minimum output.* The high-frequency signal superimposed on the dc output should be ignored. The required frequencies are as follows:

AVCS

Black Discriminator (labeled Discriminator III, in Fig. 1)
200-kc input-tune for maximum output at Test Point A
230-kc input-tune for minimum output at Test Point A

White Discriminator (labeled Discriminator II, in Fig. 1)
208-kc input-tune for maximum output at Test Point D
238-kc input-tune for minimum output at Test Point D

HRIR

"Cold" Discriminator (labeled Discriminator III, in Fig. 2)
248-kc input-tune for maximum output at Test Point A
288-kc input-tune for minimum output at Test Point A

"Hot" Discriminator (labeled Discriminator II, in Fig. 2)
262-kc input-tune for maximum output at Test Point D
302-kc input-tune for minimum output at Test Point D.

The discriminators are all tuned within a few hundred cycles of the correct frequencies. The vernier adjustment is made using a simulated grid-point signal. The outboard grid-point signal generator supplied with the rack (shown in Fig. 5) is operated by plugging the black lead into the ground test point and the red lead into the +20 volt test point of any of the six units. This oscillator generates grid points at a high rate. These can be plugged in the "Grid Insert" jack for alignment purposes. In addition, any oscillator signal of sufficient amplitude (negative-going pulse of greater than 5 volts) can be used for simulated grid signals.

The test oscillator is plugged into the "Video Insert" jack, the demodulator on the test panel is switched to the unit being aligned, and the gridded output is observed by connecting the oscilloscope to the demodulated output. With the test oscillator approximately in the center of the signal range (25 kc for AVCS and 73 kc for HRIR) the waveforms shown in picture 15 will be observed. To insure that the excursions of the grid points are at the correct frequencies, the frequency of the test oscillator is adjusted, using the counter, to the black and white (hot and cold for HRIR) frequencies. *Either coil of the corresponding*

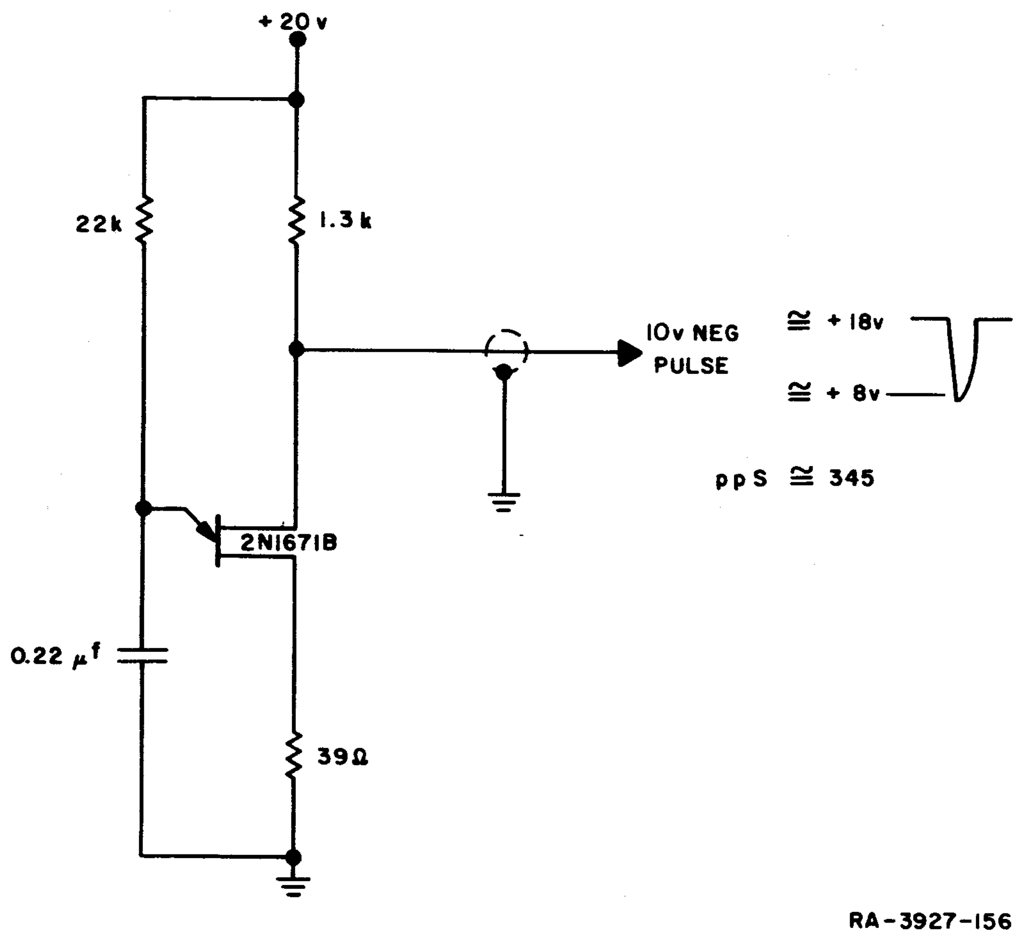


FIG. 5 GRID-POINT INJECTOR

discriminator is adjusted so as to place the black or white point at the same demodulated output level as that of the input signal. Following the coarse set-up, the black and white points will probably be found to be slightly above or below the line corresponding to the correct frequency. The black and white, and hot and cold frequencies for the test oscillator to be adjusted to for the vernier alignment are listed below:

AVCS

White Discriminator (labeled Discriminator II, in Fig. 2) input at 29.4 kc
Black Discriminator (labeled Discriminator III, in Fig. 1) input at 21.0 kc

HRIR

Hot Discriminator (labeled Discriminator II, in Fig. 3) input at 80.0 kc
Cold Discriminator (labeled Discriminator III, in Fig. 3) input at 66.0 kc.

C. OUTPUT LEVEL

The units, when properly terminated, are designed to operate with one volt p-p input and output. This is normally obtained by first setting the input level control at its mid-point, and setting the output level control to one volt PP with a one-volt PP signal plugged into the video insert jack. The input-level control should only be changed for operation with input signals less than or greater than one volt. Both of the amplitude controls are on Card 5.

D. GRID-POINT WIDTHS

The grid-point width adjustments require the use of the simulated grid-point generator plugged into the "Grid Insert" jack, and receiving power from any of the +20 volt supplies. Each control has an associated test point on Card 1 for observing the width of the corresponding black or white pulse. These are itemized below:

AVCS

White pulse width (labeled Monostable I, in Fig. 2)
read on Test Point B

Black pulse width (labeled Monostable II, in Fig. 2)
read on Test Point A

HRIR

"Hot" pulse width (labeled Monostable I, in Fig. 3)
read on Test Point B
"Cold" pulse width (labeled Monostable II, in Fig. 3)
read on Test Point A.

E. STAGGER-TUNED AMPLIFIERS

The staggered triple should not require retuning in normal usage. If either a tuning coil or capacitor is changed, the triple can be retuned by applying the required high-frequency signals directly to the "Video Insert" jack using the test oscillator and counter. The test oscillator is adjusted alternately to each of the tuning frequencies. Card 5, the card containing the triple, is placed on the card extender to make the tuning coils available. The oscilloscope is connected to the limiter input which is Test Point B on Card 3. Starting with the first tuned circuit, which is the mixer output transformer, the coils are maximized using the following frequencies:

AVCS-220.9 kc, 211.5 kc, and 201.7 kc

HRIR-285.85 kc, 273.75 kc, and 262.15 kc.

Following this three-point alignment, the test oscillator can be manually swept through the band with the limiter input observed for a constant output level. The individual coils can be slightly readjusted for the flattest response, although this will usually not be required.

F. OSCILLATOR BALANCE (AVCS Only)

This adjustment needs to be made only after a component change in the balanced mixer. The grid-point generator is plugged into the "Grid Insert" jack with *no* input video signal (test oscillator or normal input) coming into the video input. The latter can be accomplished with a bare plug in the "Video Insert" jack. The oscillator balance control is then adjusted for minimum output at the limiter input which is Test Point B on Card 3.

G. OSCILLATOR REJECTION AND OUTPUT TUNING (HRIR Only)

Neither of these adjustments on Card 7 should need re-setting after an initial alignment. The oscillator rejection is accomplished by an emitter trap. A card extender is used to make the tuning coil available. In the absence of video input, it is tuned for minimum output signal at the 200-kc oscillator frequency. The output is observed on Test Point A of Card 7.

The output tank circuit is available from the front and is tuned by using the test oscillator as the video input and setting it to 73 kc. The output is then maximized by observing the video output. Since the circuit is very low Q and difficult to maximize, it can be retouched by observing the flatness of the over-all passband from 66 to 80 kc, and tuned accordingly to favor the high or low side.

V MAINTENANCE

If any unit were to malfunction while pictures are being gridded, the immediate solution would be to interchange a spare with the defective unit, using the convenient front-panel plugs. The defective unit should first be checked for a malfunction in one of its four power supplies. These outputs are available at the front panel and can be readily checked with an oscilloscope or voltmeter. If they are operating properly, a more systematic check will be required. Figure 6 shows the power wiring for both AVCS and HRIR.

The malfunction can be classified into one of two categories, improper signal handling and improper gridding. The first category simply states that, in the absence of grid pulses, the output video signal is unlike the input. If the output signal does not exist, the input signal can be traced through the test points in the following order:

AVCS—video input, filter input, filter output, base of second mixer video output

HRIR—video input, base of second mixer, video output.

If the signal exists at the video input point, but not at the base of the second mixer, in addition to the intervening amplifier circuitry the controlled oscillator should be checked for operation using the appropriate test point. If the signal exists at the base of the second mixer and not at the video output, in addition to checking the intervening amplifier circuitry the crystal oscillator should be checked at the appropriate test point. The correct waveform for each test point is given in the oscilloscope photographs in Appendices A and B.

If the pass-band between input and output is poor, as indicated by manually sweeping the test oscillator through the band, it can be realigned as indicated in the alignment section.

If the signal is highly distorted during the duration of the grid pulses, the discriminators on Card 3 should be checked for operation and alignment. A gross mistuning of either discriminator can cause the signal during either a black or white point to leave the pass-band, causing a hole in the output signal.

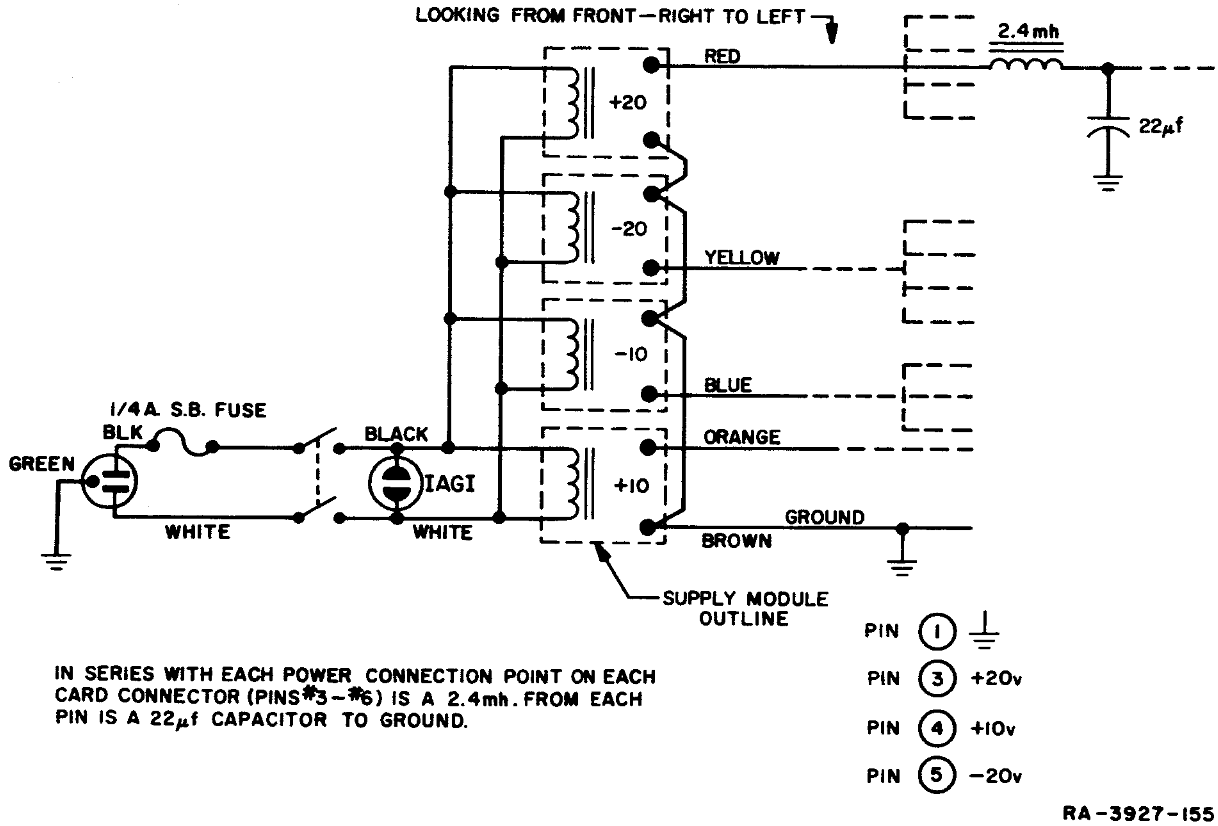


FIG. 6 POWER WIRING – HRIR AND AVCS

A. LACK OF GRIDDING

If gridding is not taking place when grid pulses are inserted, the problem lies somewhere in the switching system consisting of Cards 1 and 2.

If there is no response to an input grid pulse, then the first monostable on Card 1 is probably not firing. The output of the first monostable appears on Test Point B and should be a negative pulse starting from +15 volts and going to approximately ground, the leading edge coincident with the input grid pulse.

B. NO "BLACK" PULSE

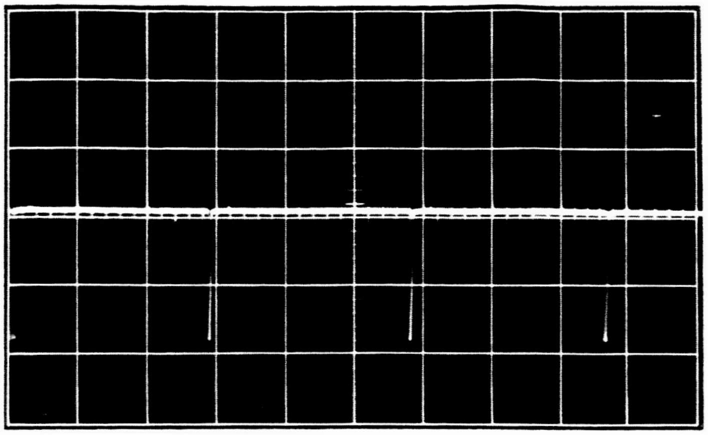
If the input grid pulse causes only a "white" pulse in the video signal, then the second monostable is probably not firing. The output of the second monostable appears on Test Point A, and is similar to the output of the first monostable except that the leading edge is coincident with the trailing edge of the pulse from the first monostable.

C. ERRATIC FREQUENCIES GENERATED DURING GRIDDING

One or more of the transistors in the gating circuits on Card 2 may have failed. The voltages directly driving the diode gates may be observed on the test points. The "−off" points (Test Points A, C, E) should be at −10 volts when the respective gates are "disconnected," and at the oscillator control voltage, approximately ground, at times when the gate is "connected." The "+off" points (Test Points B, D, F) should be at +10 volts when the respective gates are "disconnected," and at the oscillator control voltage when the gates are "connected." At any instant of time, only one of the gates is "connected," the other two being "disconnected." In the absence of a grid pulse, only the first gate (Test Points E, F) is "connected." The grid pulse causes the second gate (Test Points B, C) to become "connected" for the duration of the firing of the first monostable, immediately followed by the "connection" of the third gate (Test Points A, B) during the firing of the second monostable. If the proper signals appear on all six test points, then one of the gating diodes has probably become open. These may be checked with an ohmmeter.

APPENDIX A

OSCILLOSCOPE PHOTOGRAPHS OF TEST POINTS OF THE AVCS UNIT



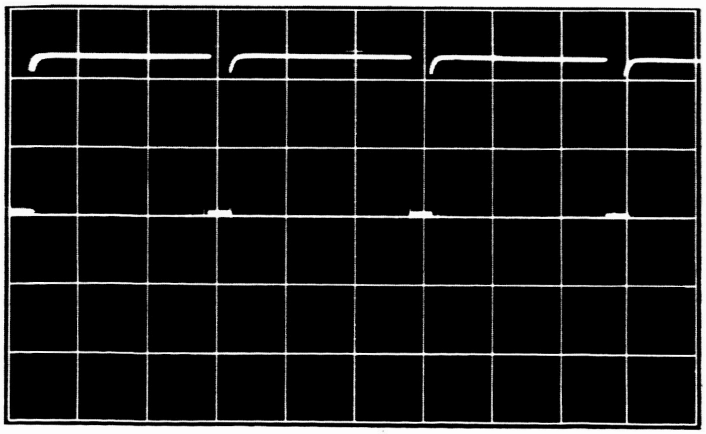
CARD 1

Test Point C--"Input Grid Pulse"

Ground at bottom

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 1

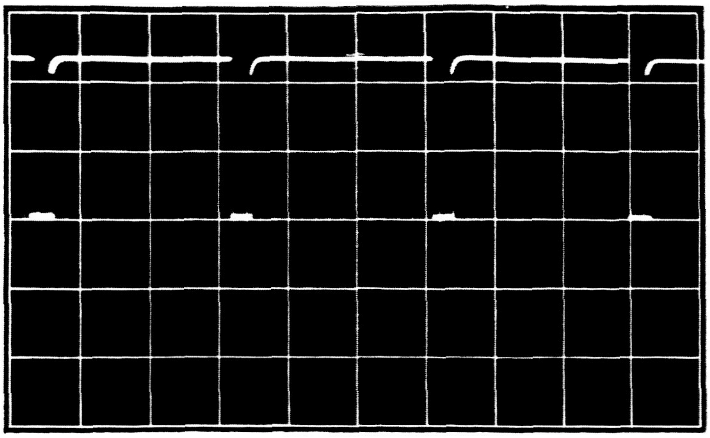
Test Point B--"First Monostable, 220 kc"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-172



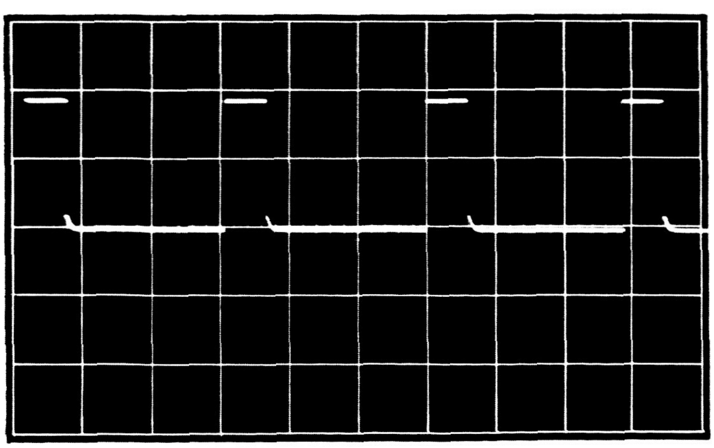
CARD 1

Test Point A--"Second Monostable, 211.25 kc"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 2

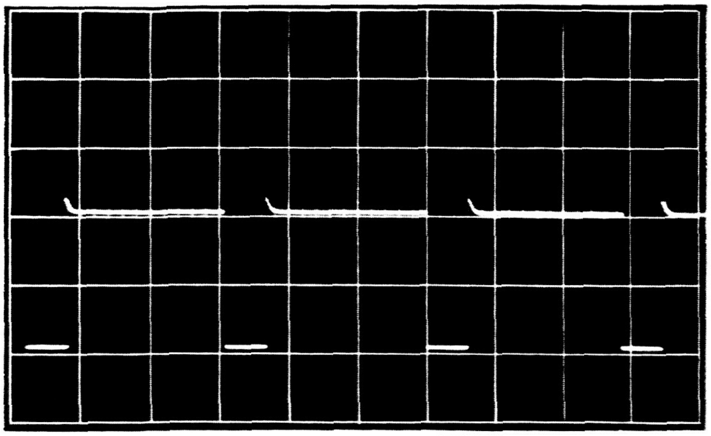
Test Point F--"Gate Control Voltage, 190 kc, + OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-173



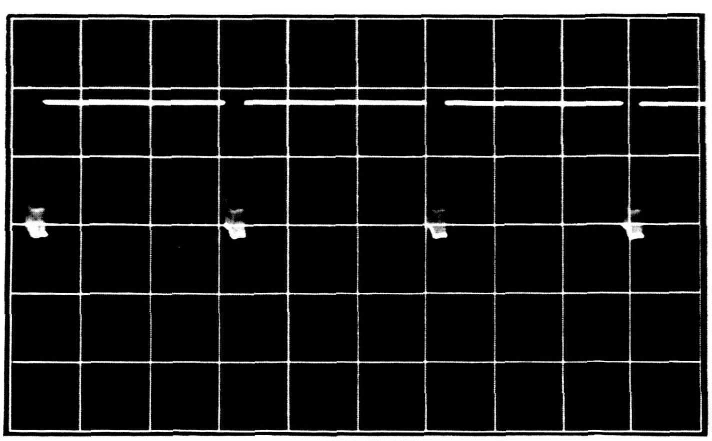
CARD 2

Test Point E--"Gate Control Voltage, 190 kc, - OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 2

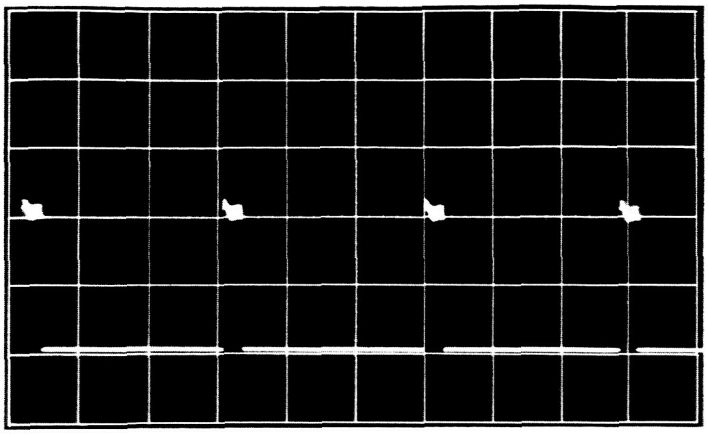
Test Point D--"Gate Control Voltage, 220 kc, + OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-174



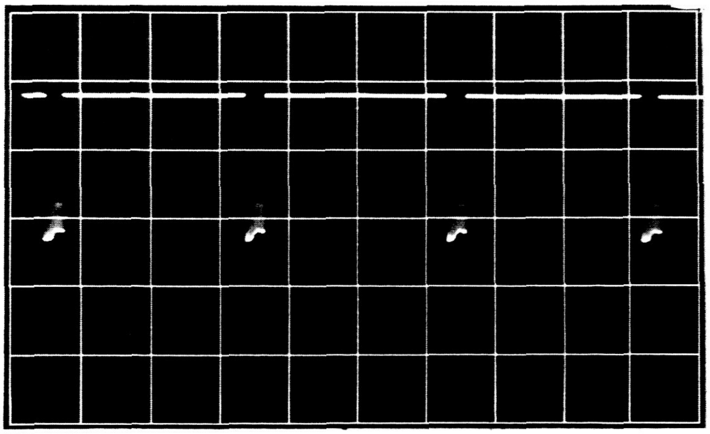
CARD 2

Test Point C--"Gate Control Voltage, 220 kc, - OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 2

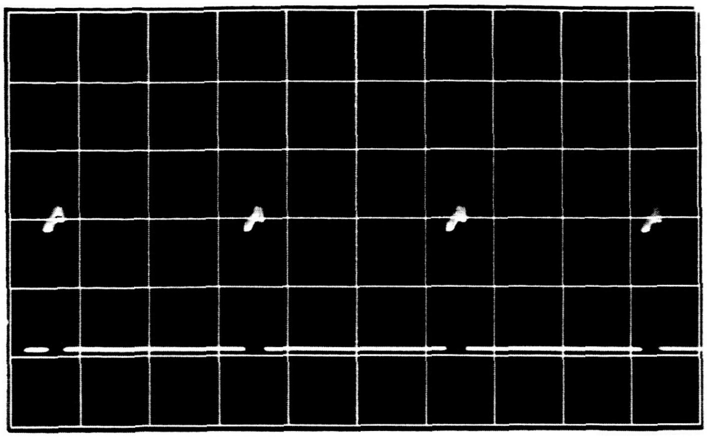
Test Point B--"Gate Control Voltage, 211.25 kc, + OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-175



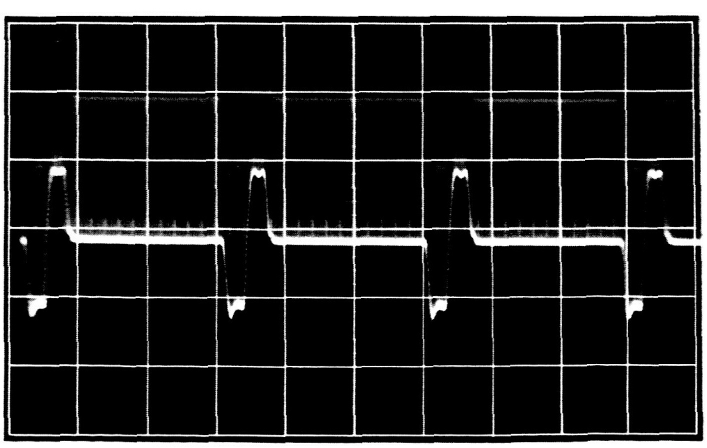
CARD 2

Test Point A--"Gate Control Voltage, 211.25 kc, - OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 3

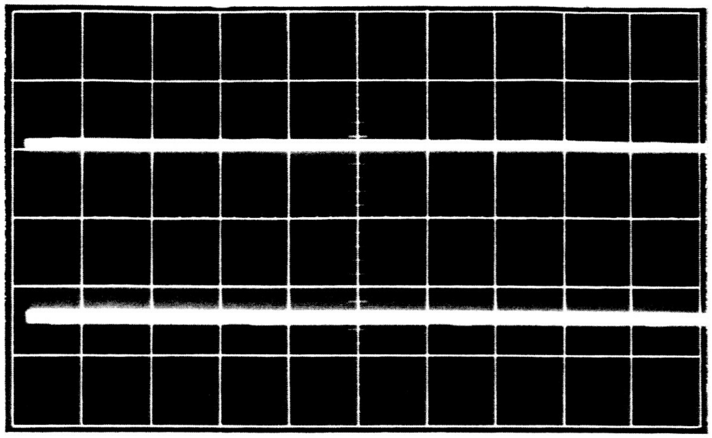
Test Point D--"220 kc Discrim. Out"

Ground 1 cm below center

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

Triggered on grid pulse

RA-3927-176



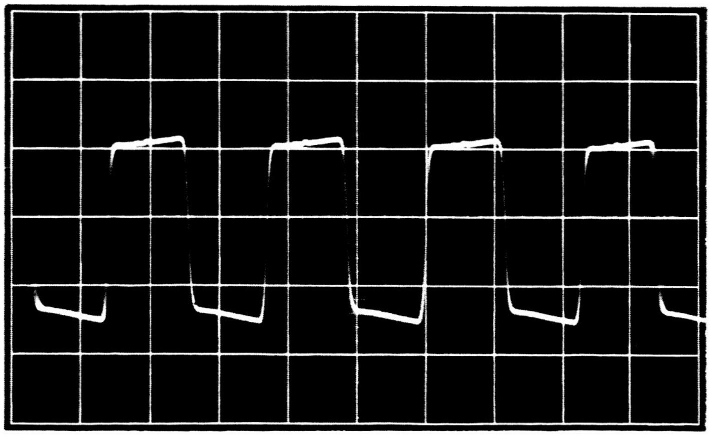
CARD 3

Test Point C--"Limiter Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

AC coupled

Grid pulses inserted



CARD 3

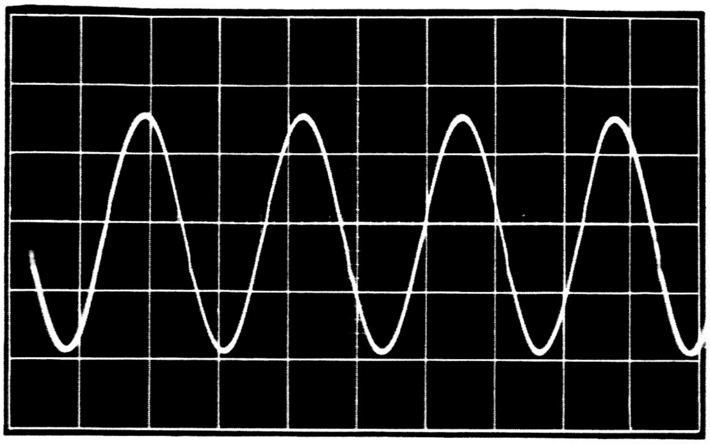
Test Point C--"Limiter Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 2 μsec/cm

AC coupled

No grid pulses inserted

RA-3927-177



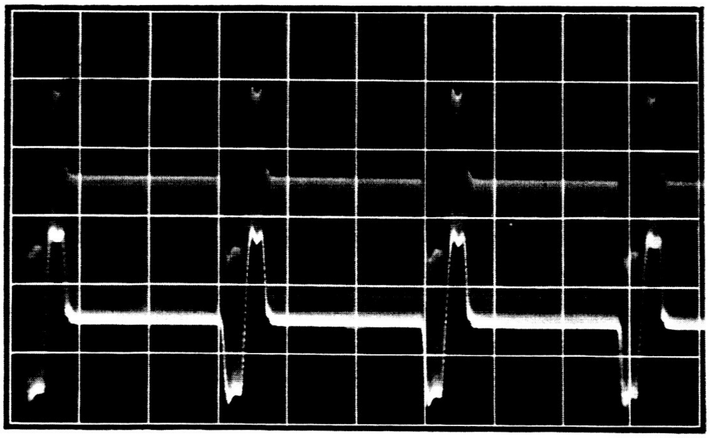
CARD 3

Test Point B--"Limiter Input"

Vertical calibration: 0.5 v/cm
Horizontal calibration: 2 μsec/cm

AC coupled

No grid pulses



CARD 3

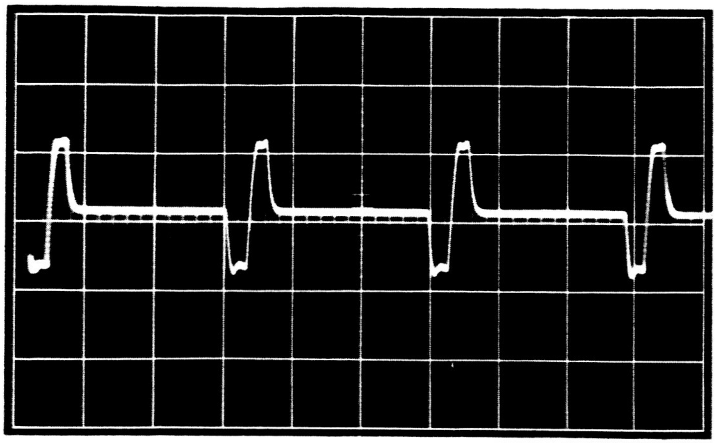
Test Point A--"211 kc Discrim. Out"

Ground at middle

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses

RA-3927-178



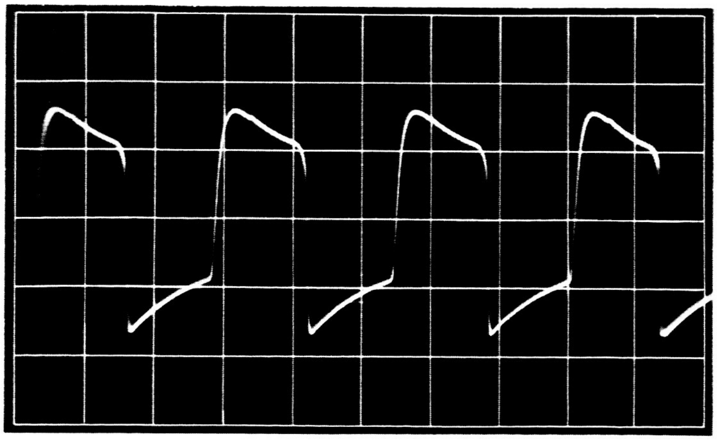
CARD 4

Test Point D--"Discrim. Out"

Ground at middle

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses



CARD 4

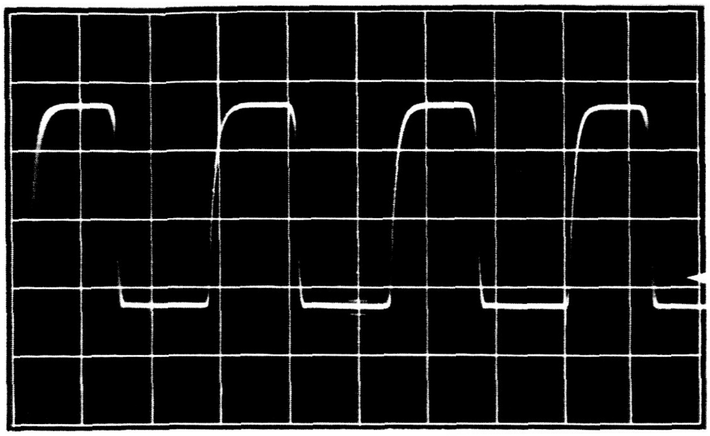
Test Point C--"Discrim. Input, 190 kc"

Vertical calibration: 1 v/cm
Horizontal calibration: 2μsec/cm

AC coupled

No grid pulses

RA-3927-179



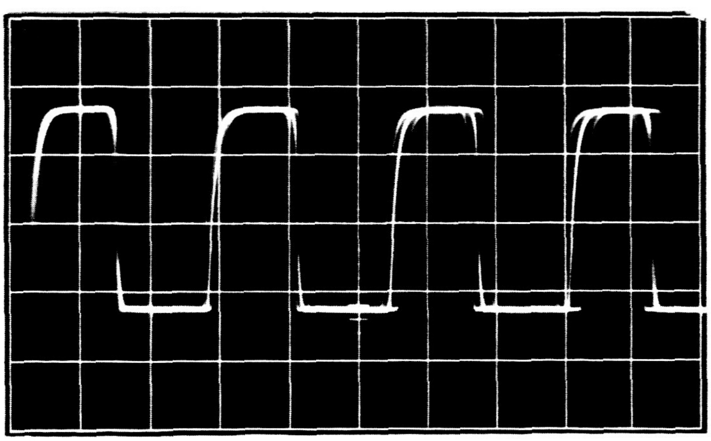
CARD 4

Test Point B--"Controlled Osc. Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 2 μsec/cm

AC coupled

No grid pulses



CARD 4

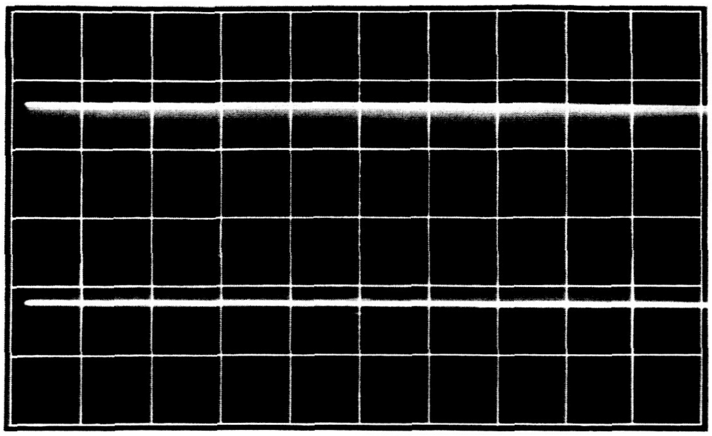
Test Point B--"Controlled Osc. Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 2 μsec/cm

AC coupled

Grid pulses

RA-3927-180



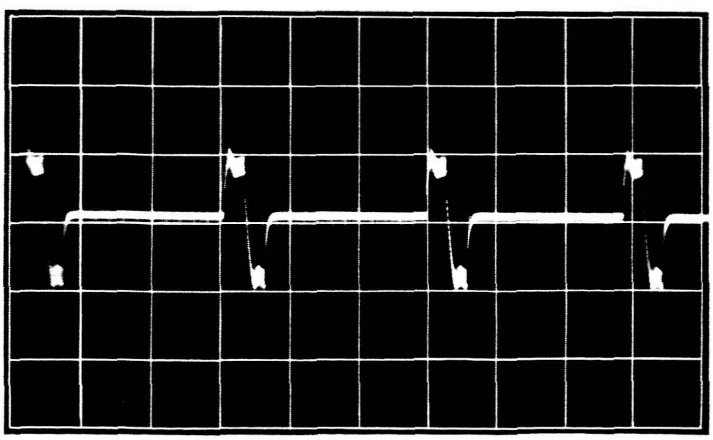
CARD 4

Test Point B--"Controlled Osc. Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

AC coupled

Grid pulses



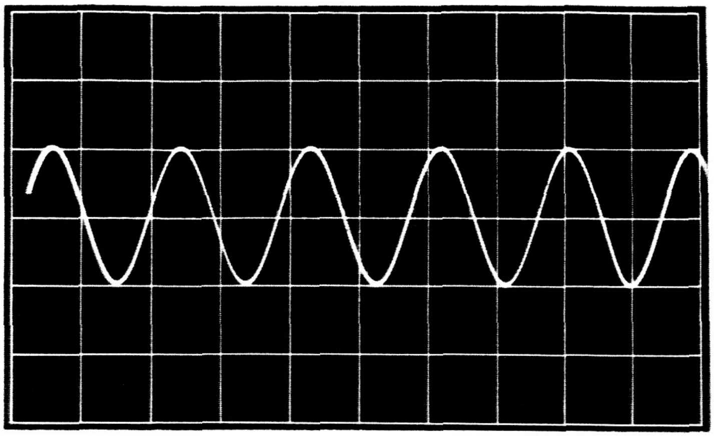
CARD 4

Test Point A--"Osc. Control Signal"

Vertical calibration: 0.1 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses

RA-3927-181

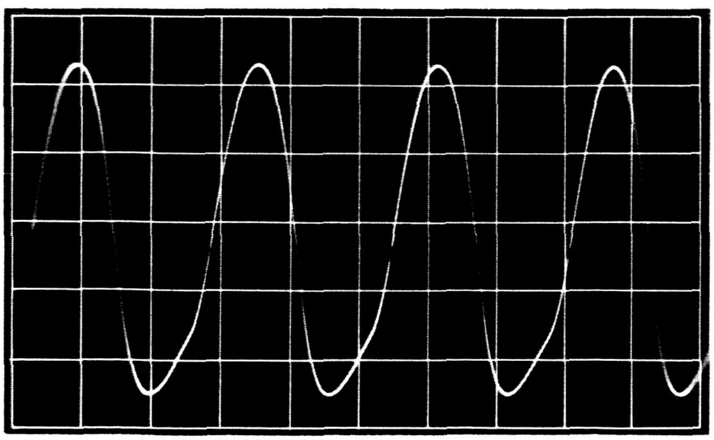


CARD 5

Test Point A--"Video Input"

Vertical calibration: 0.5 v/cm
Horizontal calibration: 20μsec/cm

AC coupled



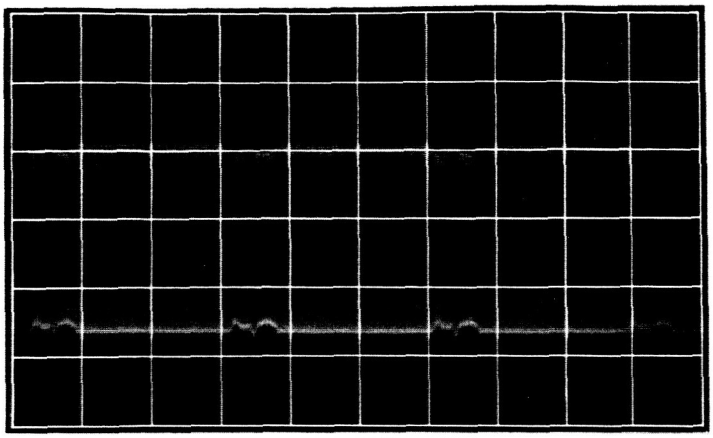
CARD 6

Test Point B--"Xtal Oscillator Output"

Vertical calibration: 2 v/cm
Horizontal calibration: 2μsec/cm

AC coupled

RA-3927-182

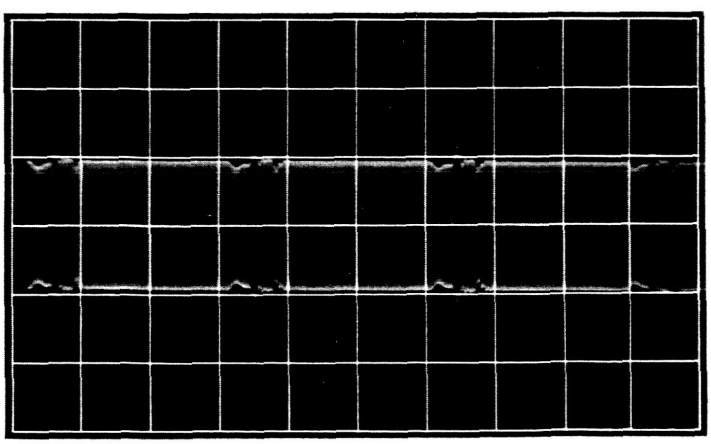


CARD 6

Test Point A--"Base of 2nd Mixer"

Vertical calibration: 0.2 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses



CARD 8

Test Point A--"Video Output"

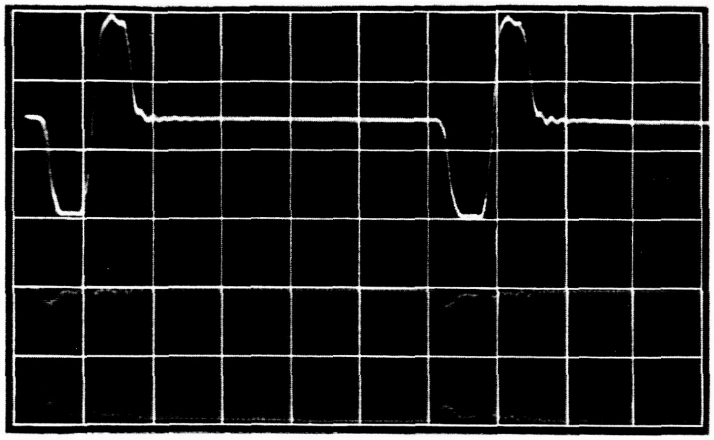
Ground at middle

Vertical calibration: 0.5 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses inserted

Test Points B and C look the same as
Test Point A, CARD 6

RA-3927-183



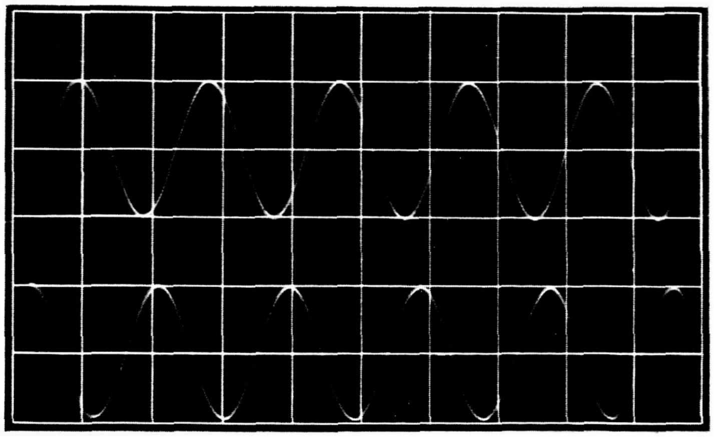
Demodulator Output

Vertical calibration: 1 v/cm
Horizontal calibration: 0.5 msec/cm

CARD 8, Test Point A--"Video Output"

Vertical calibration: 0.5 v/cm
Horizontal calibration: 0.5 msec/cm

Oscilloscope set on "Alternate Sweep"



Video Input

Input frequency: 26 kc

Vertical calibration: 0.5 v/cm
Horizontal calibration: 20 μsec/cm

CARD 8, Test Point A--"Video Output"

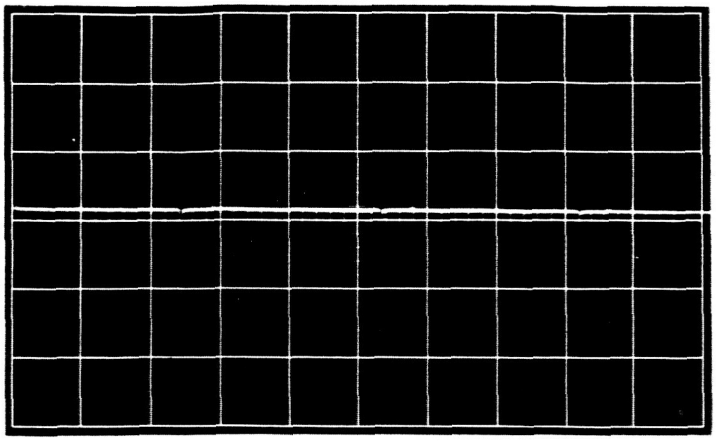
Vertical calibration: 0.5 v/cm
Horizontal calibration: 20 μsec/cm

Oscilloscope set on "Alternate Sweep"

RA-3927-184

APPENDIX B

OSCILLOSCOPE PHOTOGRAPHS OF TEST POINTS OF THE HRIR UNIT



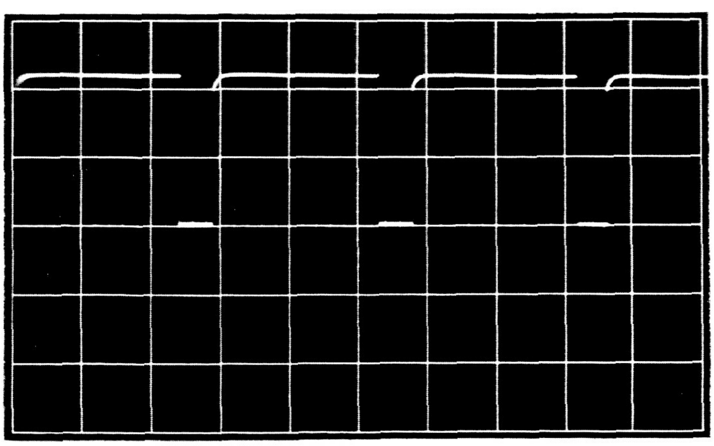
CARD 1

Test Point C--"Input Grid Pulse"

Ground at bottom

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 1

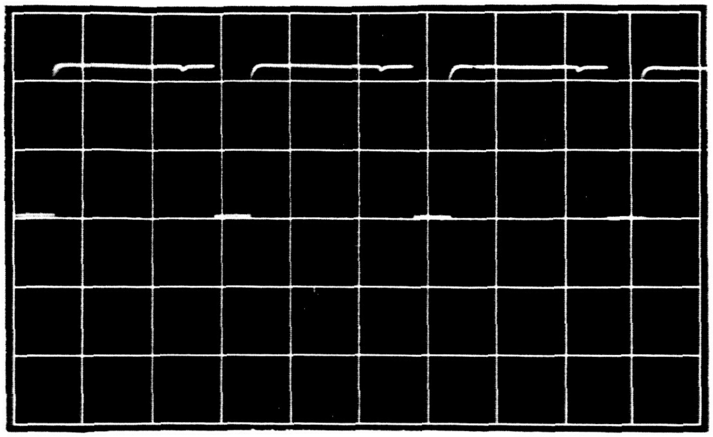
Test Point B--"First Monostable, 280 kc"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-159



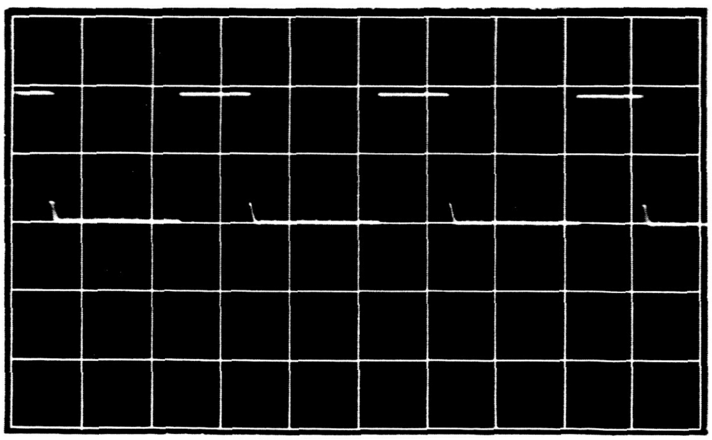
CARD 1

Test Point A--"Second Monostable, 266 kc"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 2

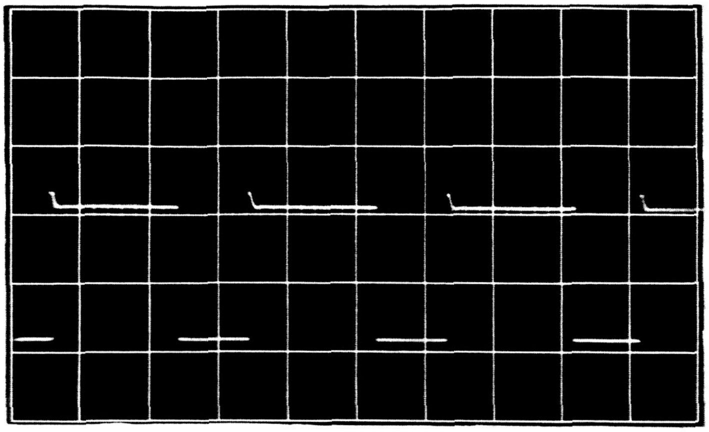
Test Point F--"Gate Control Voltage, 200 kc, + OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-160



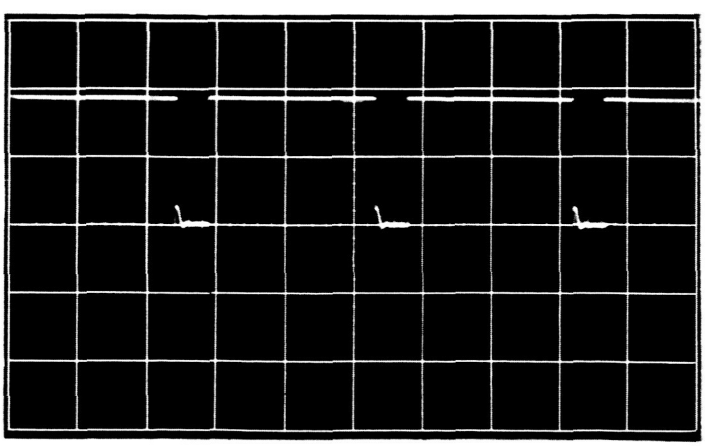
CARD 2

Test Point E-- "Gate Control Voltages, 200 kc, - OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 2

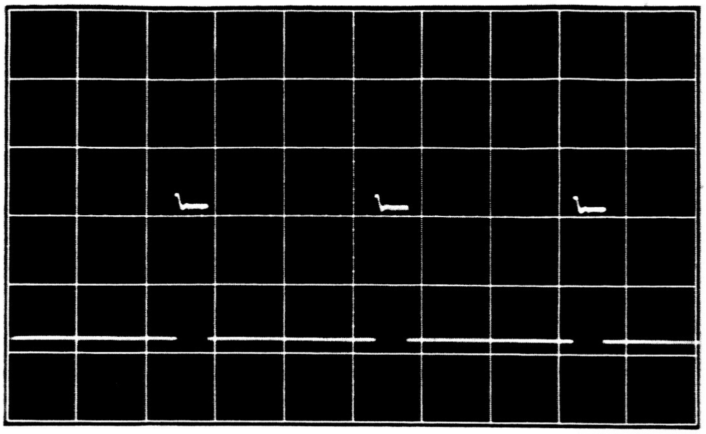
Test Point D-- "Gate Control Voltages, 280 kc, + OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-161



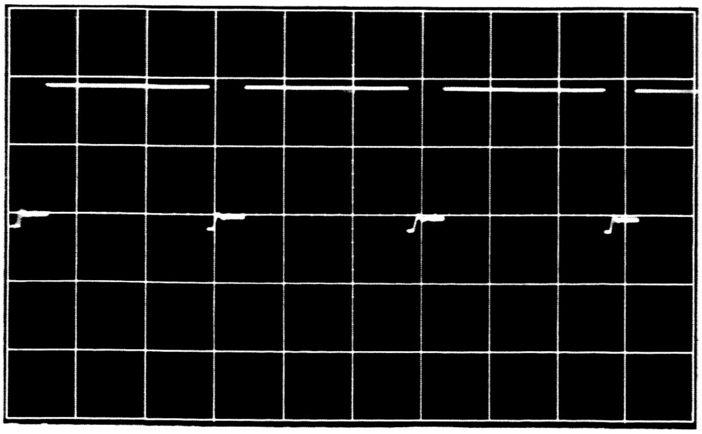
CARD 2

Test Point C--"Gate Control Voltages, 280 kc, - OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 2

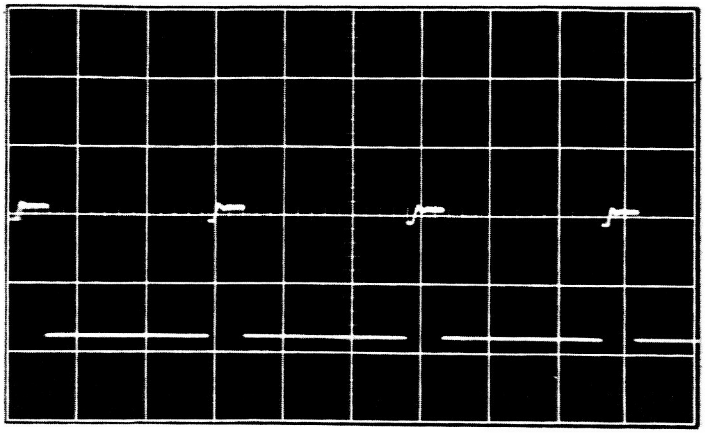
Test Point B--"Gate Control Voltages, 266 kc, + OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse

RA-3927-162



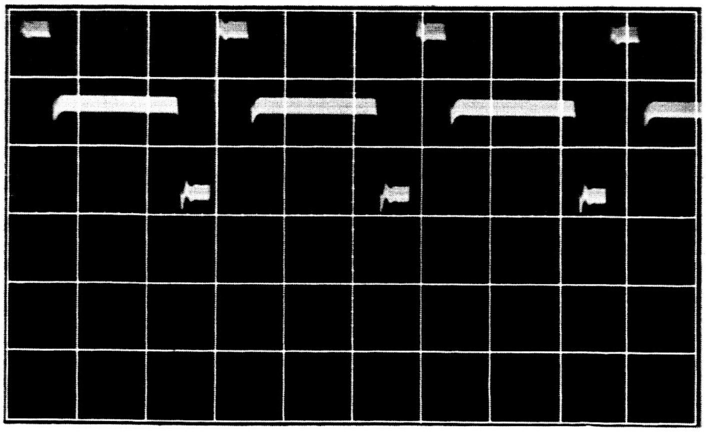
CARD 2

Test Point A-- "Gate Control Voltages, 266 kc, - OFF"

Ground at middle

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered externally on grid pulse



CARD 3

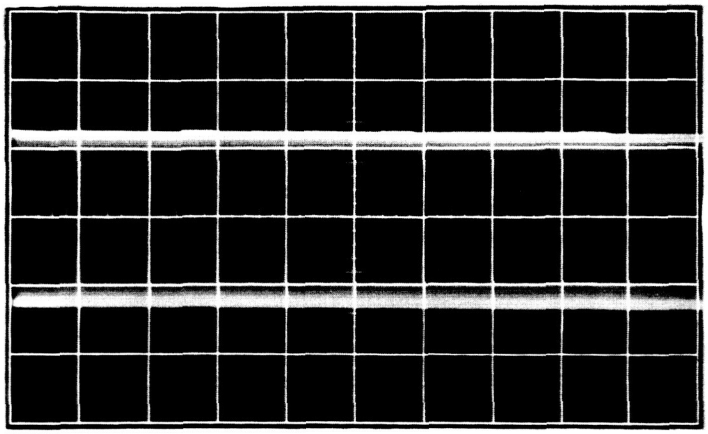
Test Point D--"280 kc Discrim. Out"

Ground 1 cm below center

Vertical calibration: 5 v/cm
Horizontal calibration: 1 msec/cm

Triggered on grid pulse

RA-3927-163



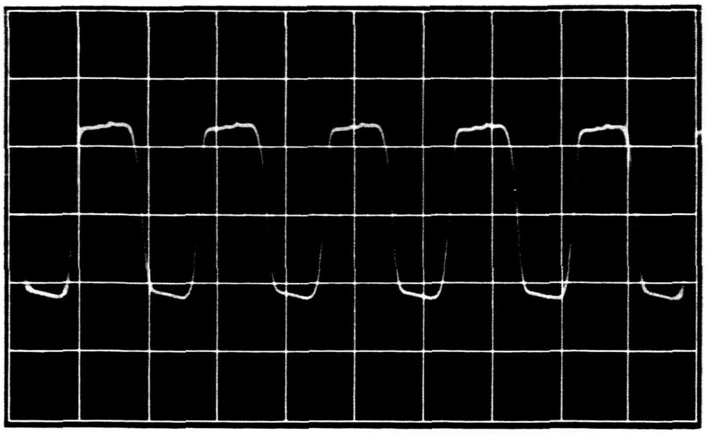
CARD 3

Test Point C--"Limiter Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

AC coupled

Grid pulses inserted



CARD 3

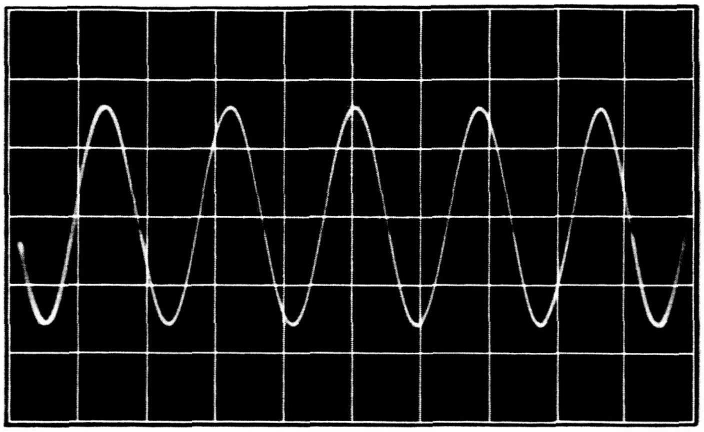
Test Point C--"Limiter Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 2 μsec/cm

AC coupled

No grid pulses inserted

RA-3927-164



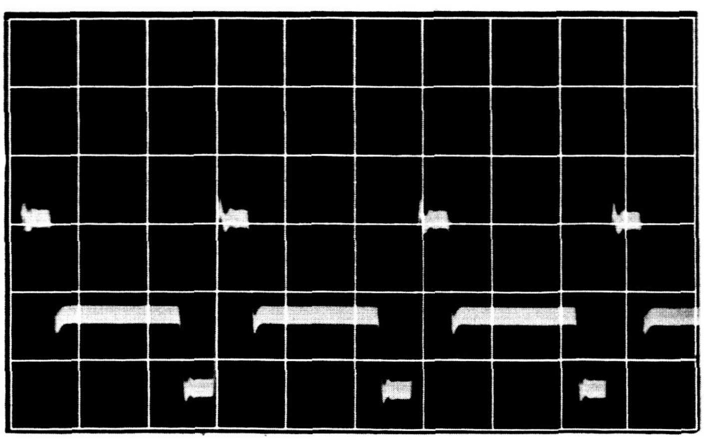
CARD 3

Test Point B--"Limiter Input"

Vertical calibration: 0.2 v/cm
Horizontal calibration: 2 μsec/cm

AC coupled

No grid pulses



CARD 3

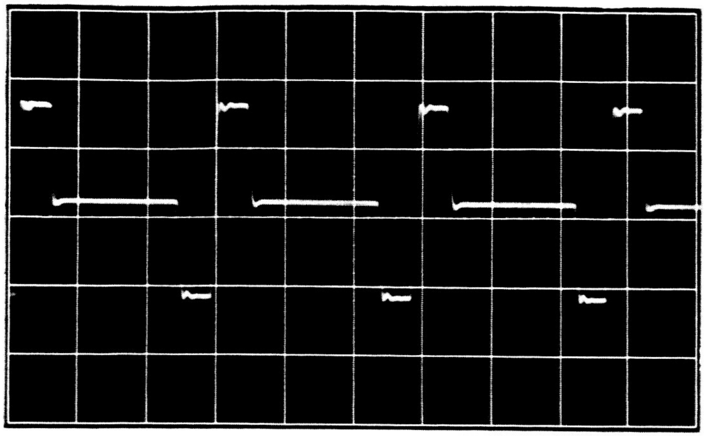
Test Point A--"266 kc Discrim. Out"

Ground at middle

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses

RA-3927-165



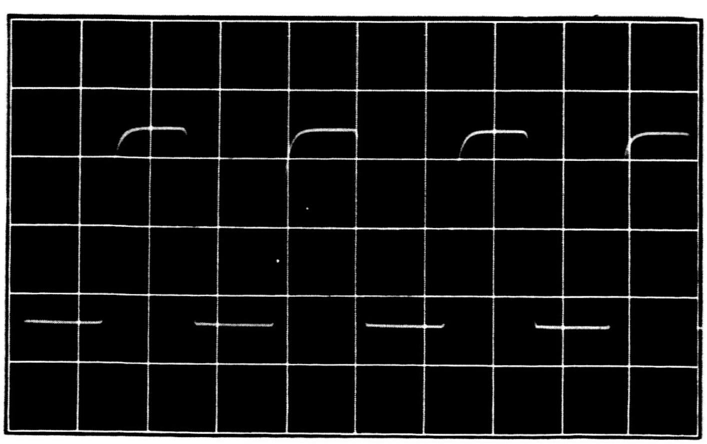
CARD 4

Test Point D--"Discrim. Out"

Ground at middle

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses



CARD 4

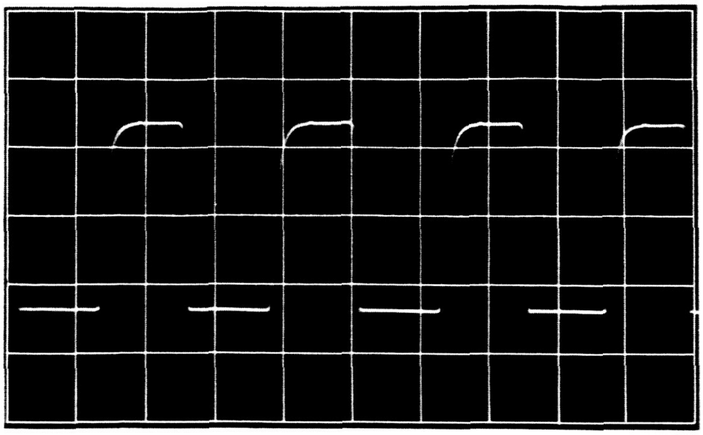
Test Point C--"Discrim. Input, 200 kc"

Vertical calibration: 1 v/cm
Horizontal calibration: 2 μsec/cm

AC coupled

No grid pulses

RA-3927-166



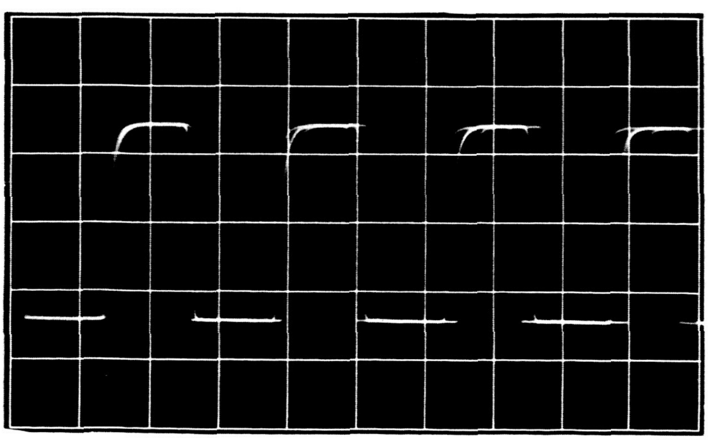
CARD 4

Test Point B--"Controlled Osc. Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 2μsec/cm

AC coupled

No grid pulses



CARD 4

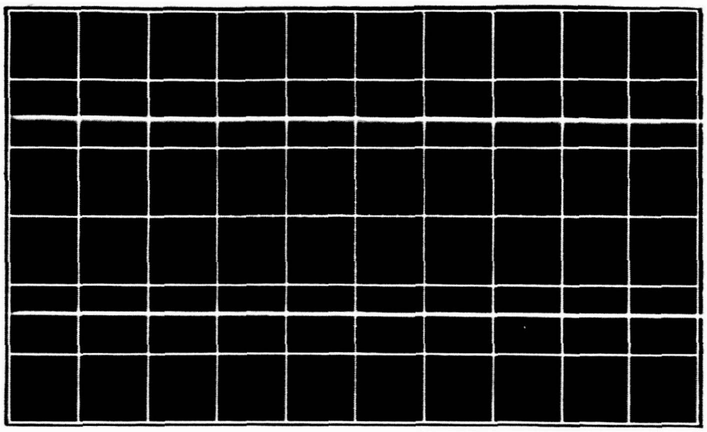
Test Point B--"Controlled Osc. Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 2μsec/cm

AC coupled

Grid pulses

RA-3927-167



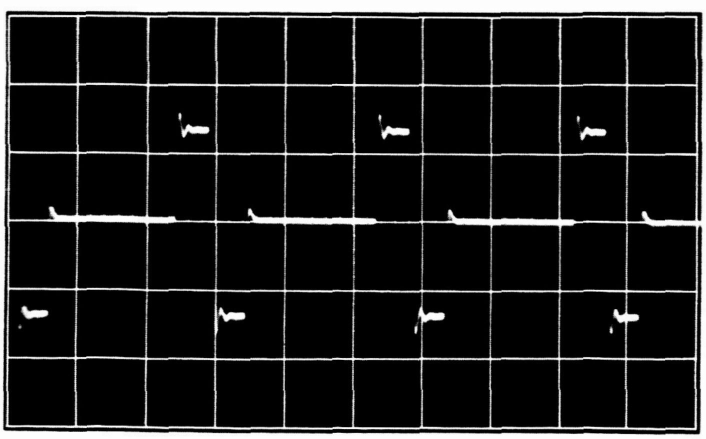
CARD 4

Test Point B--"Controlled Osc. Output"

Vertical calibration: 1 v/cm
Horizontal calibration: 1 msec/cm

AC coupled

Grid pulses



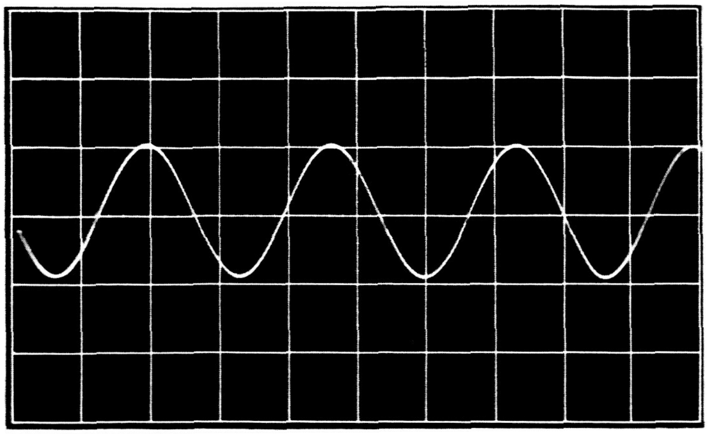
CARD 4

Test Point A--"Osc. Control Signal"

Vertical calibration: 0.1 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses

RA-3927-168

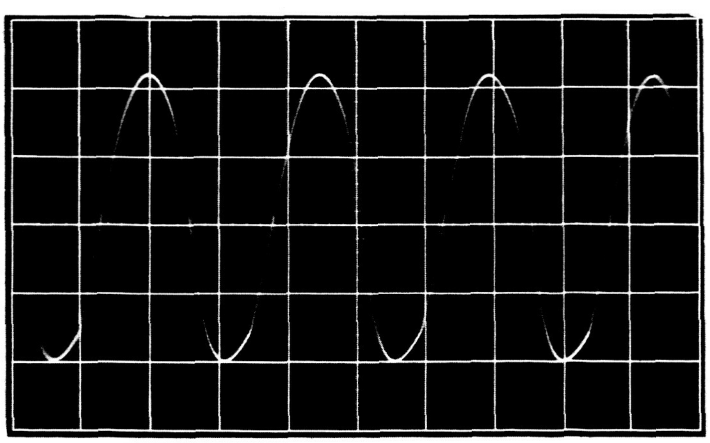


CARD 5

Test Point A--"Video Input"

Vertical calibration: 0.5 v/cm
Horizontal calibration: 5μsec/cm

AC coupled



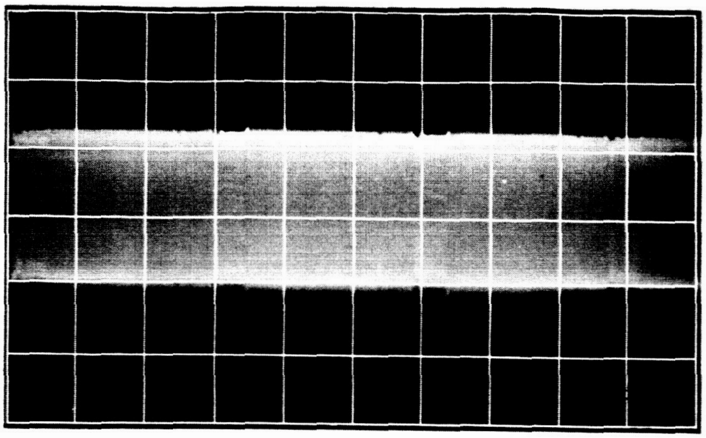
CARD 6

Test Point B-- "Xtal Osc. Output"

Vertical calibration: 2 v/cm
Horizontal calibration: 2μsec/cm

AC coupled

RA-3927-169

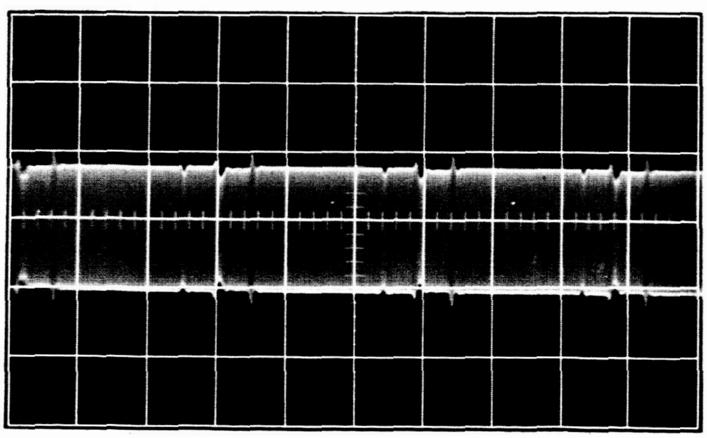


CARD 6

Test Point A--"Base of 2nd Mixer"

Vertical calibration: 0.2 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses



CARD 7

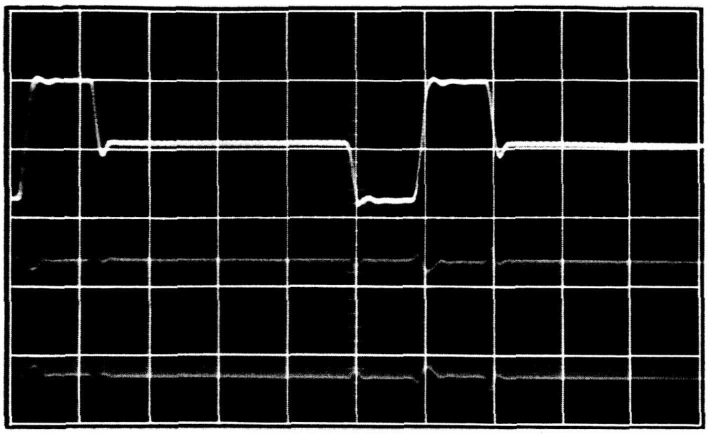
Test Point A--"Video Output"

Ground at middle

Vertical calibration: 0.5 v/cm
Horizontal calibration: 1 msec/cm

Grid pulses inserted

RA-3927-170



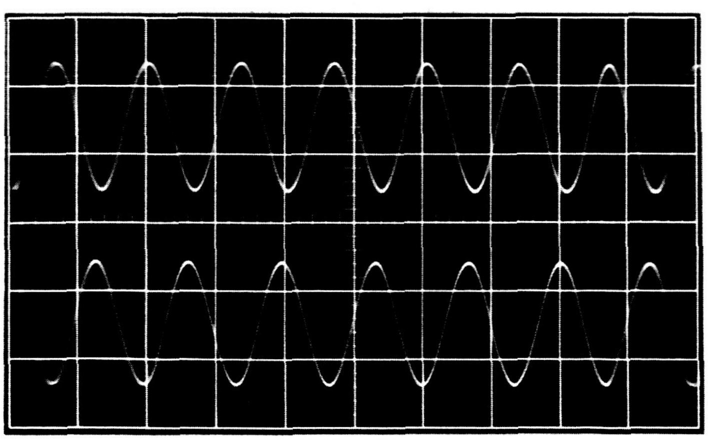
Demodulator Output

Vertical calibration: 1 v/cm
Horizontal calibration: 0.5 msec/cm

CARD 7, Test Point A--"Video Output"

Vertical calibration: 0.5 v/cm
Horizontal calibration: 0.5 msec/cm

Oscilloscope set on "Alternate Sweep"



CARD 7, Test Point A--"Video Output"

Vertical calibration: 0.5 v/cm
Horizontal calibration: 10μsec/cm

CARD 5, Test Point A--"Video Input"

Input frequency: 73 kc

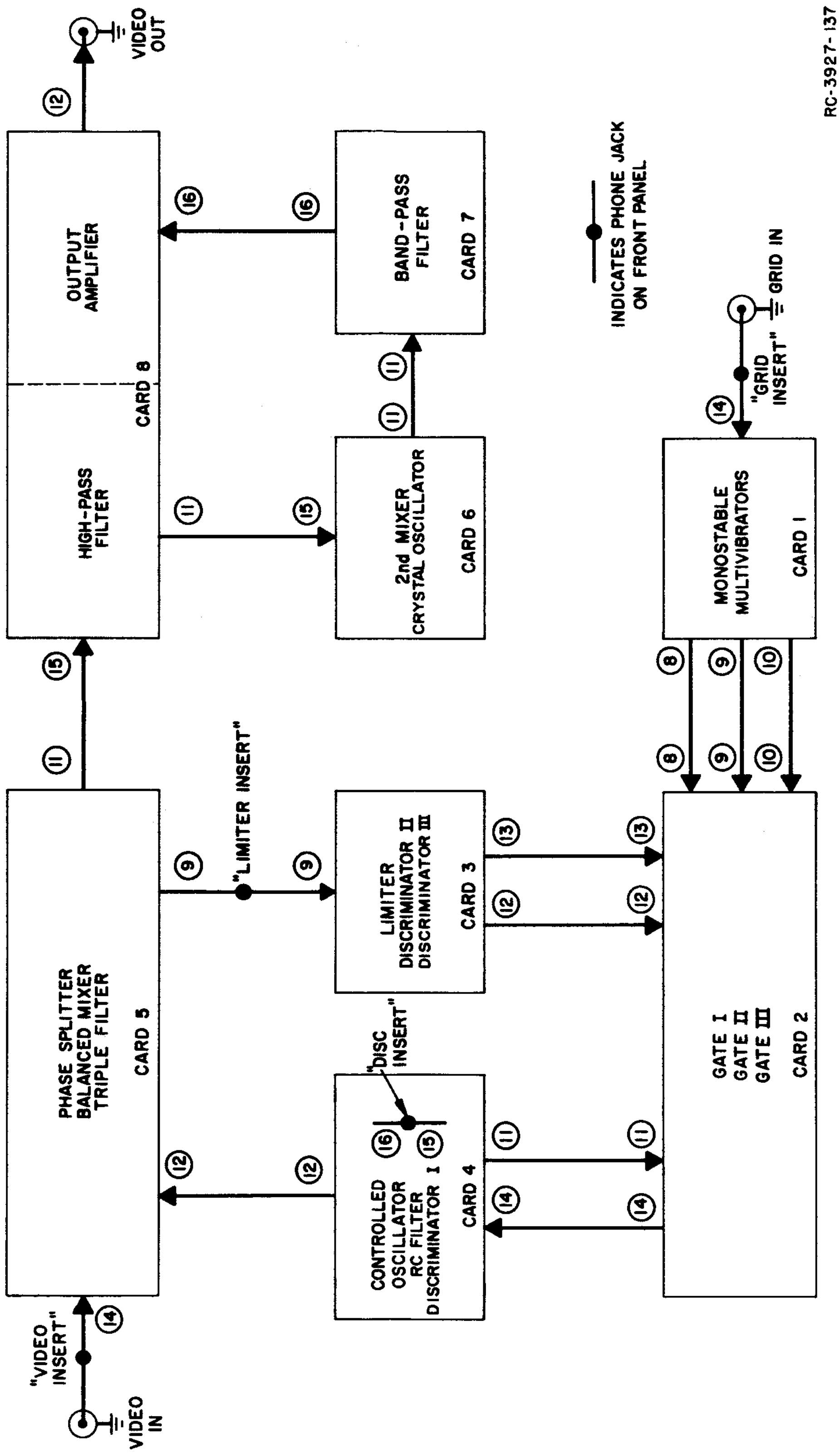
Vertical calibration: 0.5 v/cm
Horizontal calibration: 10μsec/cm

Oscilloscope set on "Alternate Sweep"

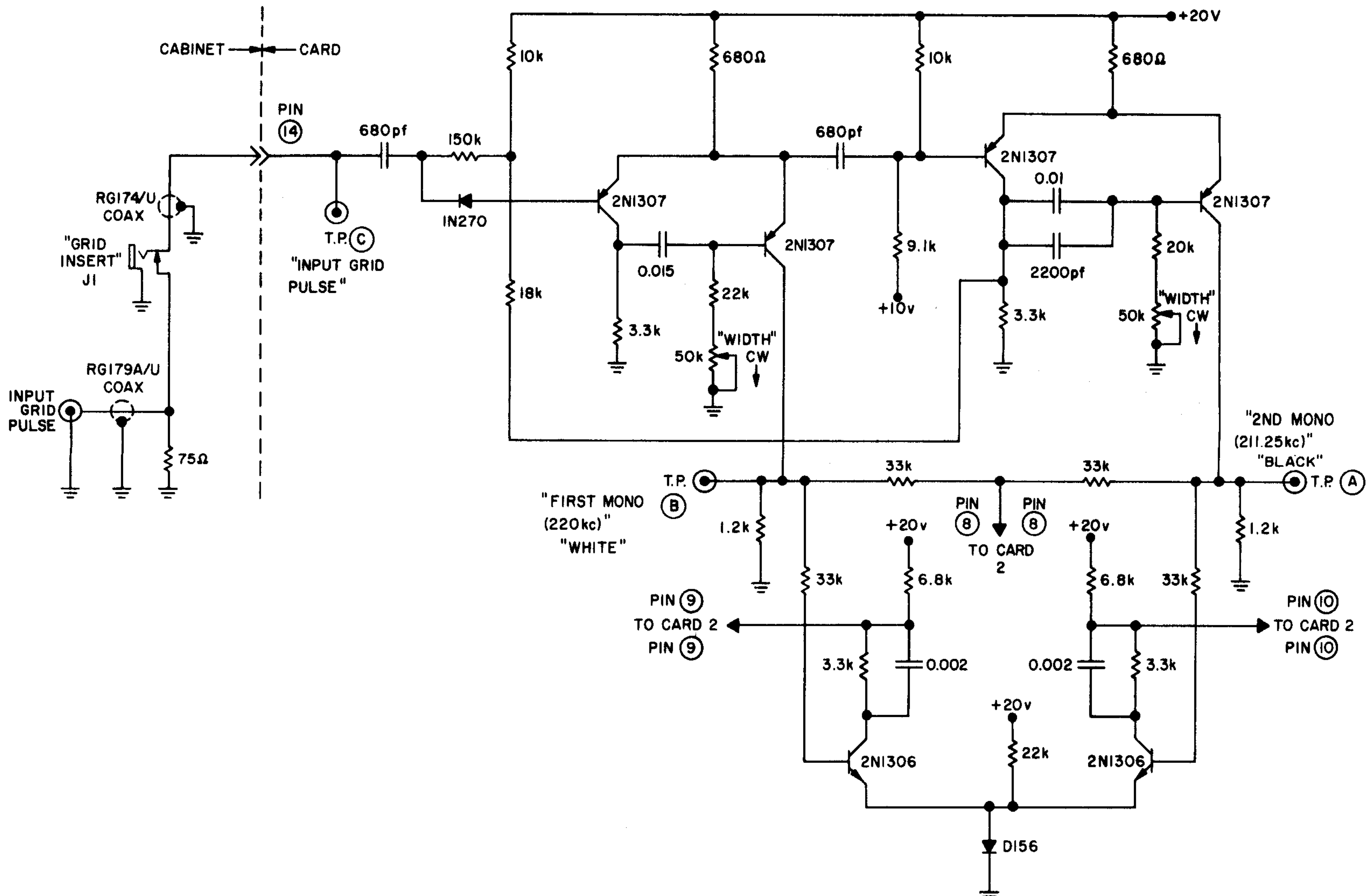
RA-3927-171

APPENDIX C

BLOCK AND SCHEMATIC DIAGRAMS OF THE AVCS UNIT



AVCS BLOCK DIAGRAM ACCORDING TO CARD LOCATION



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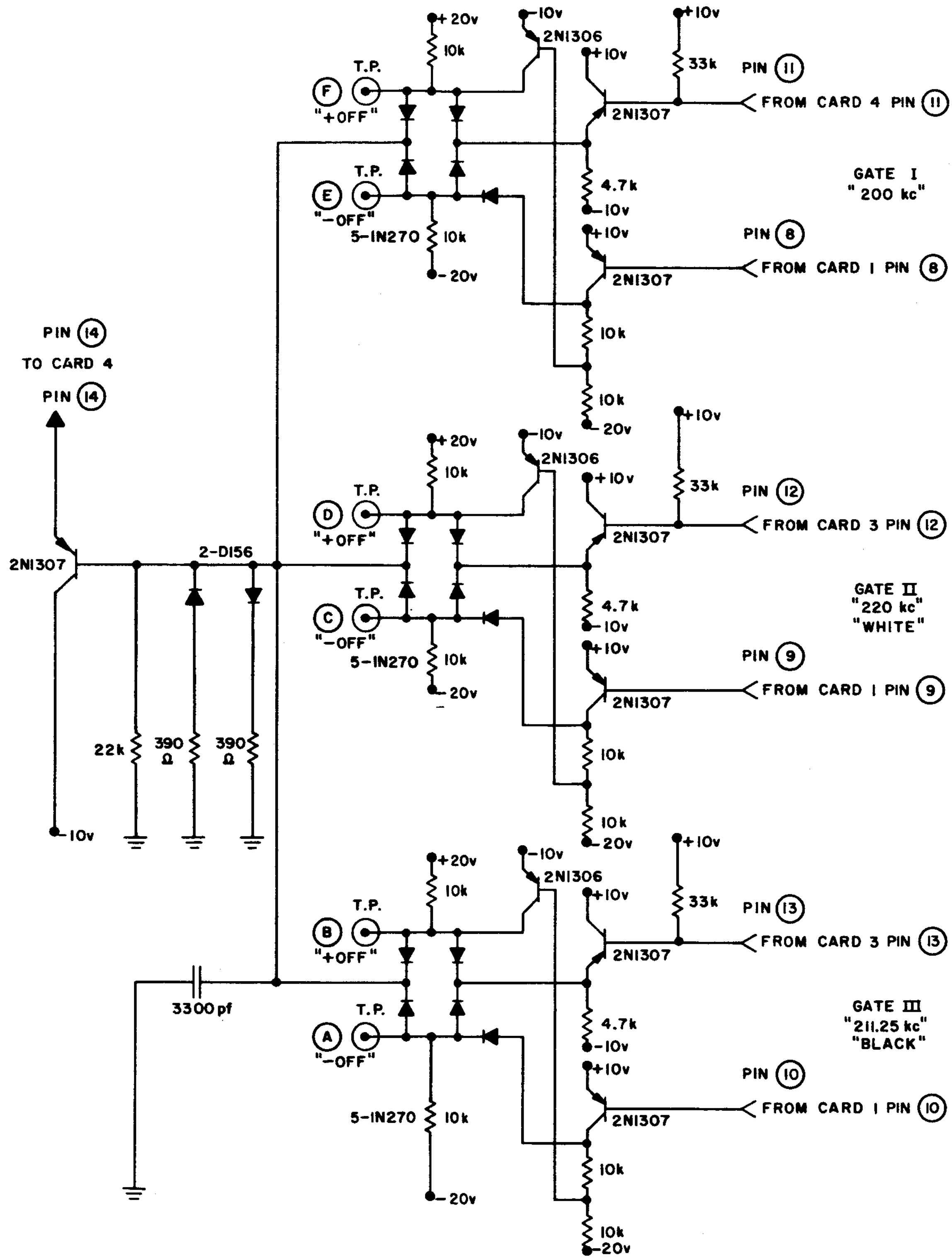
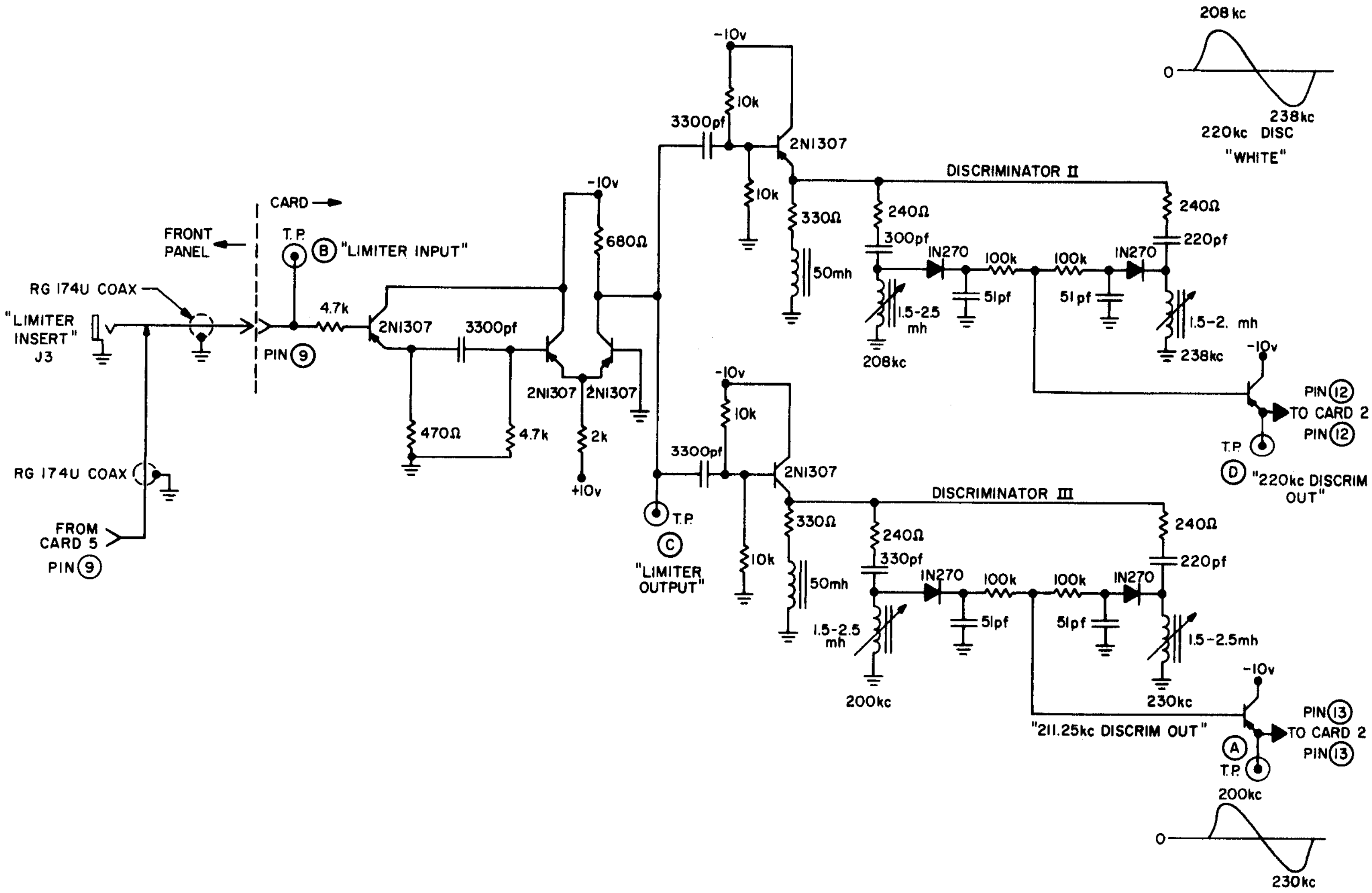
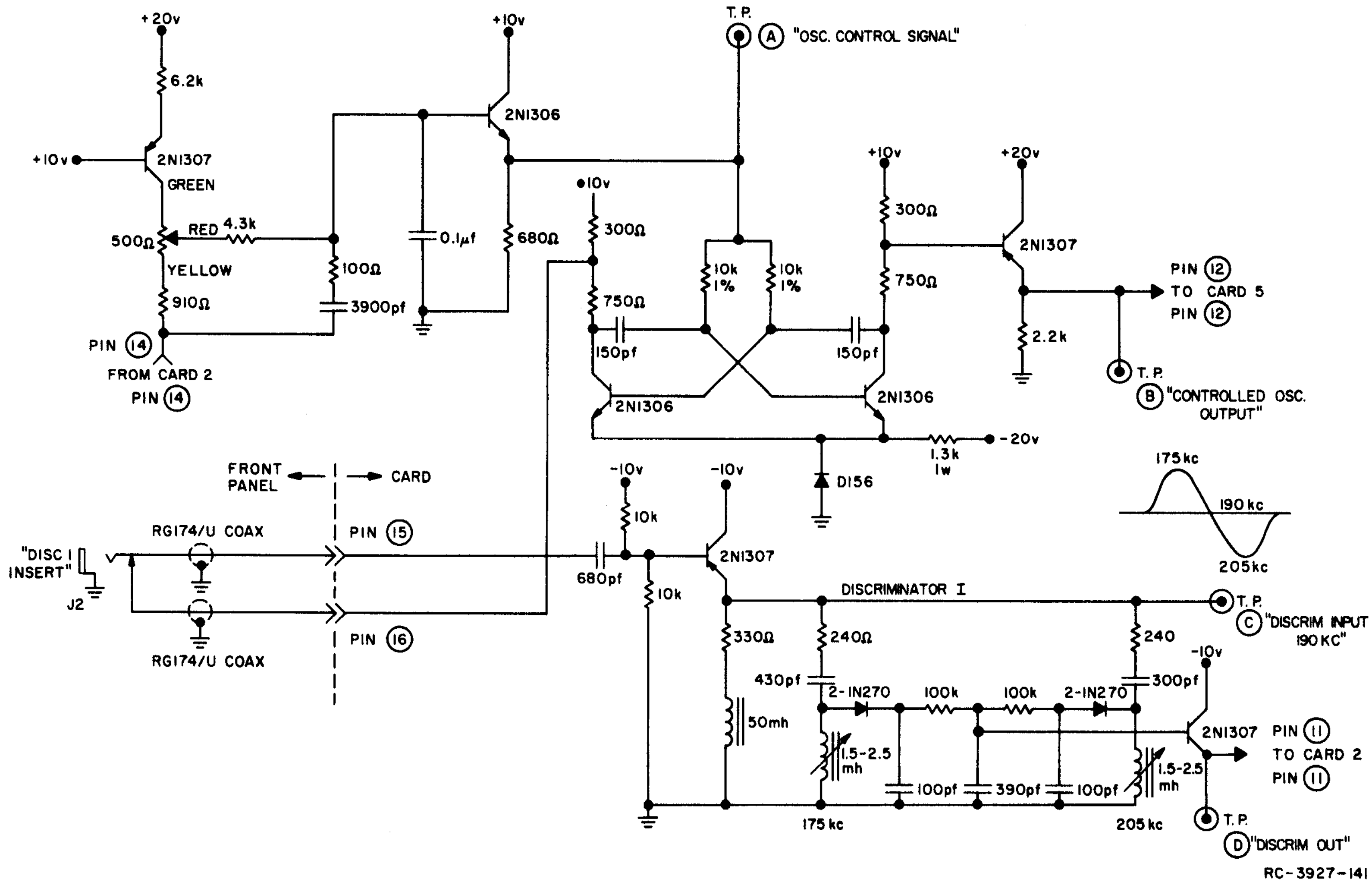
AVCS CARD I — MONOSTABLE MULTIVIBRATORS



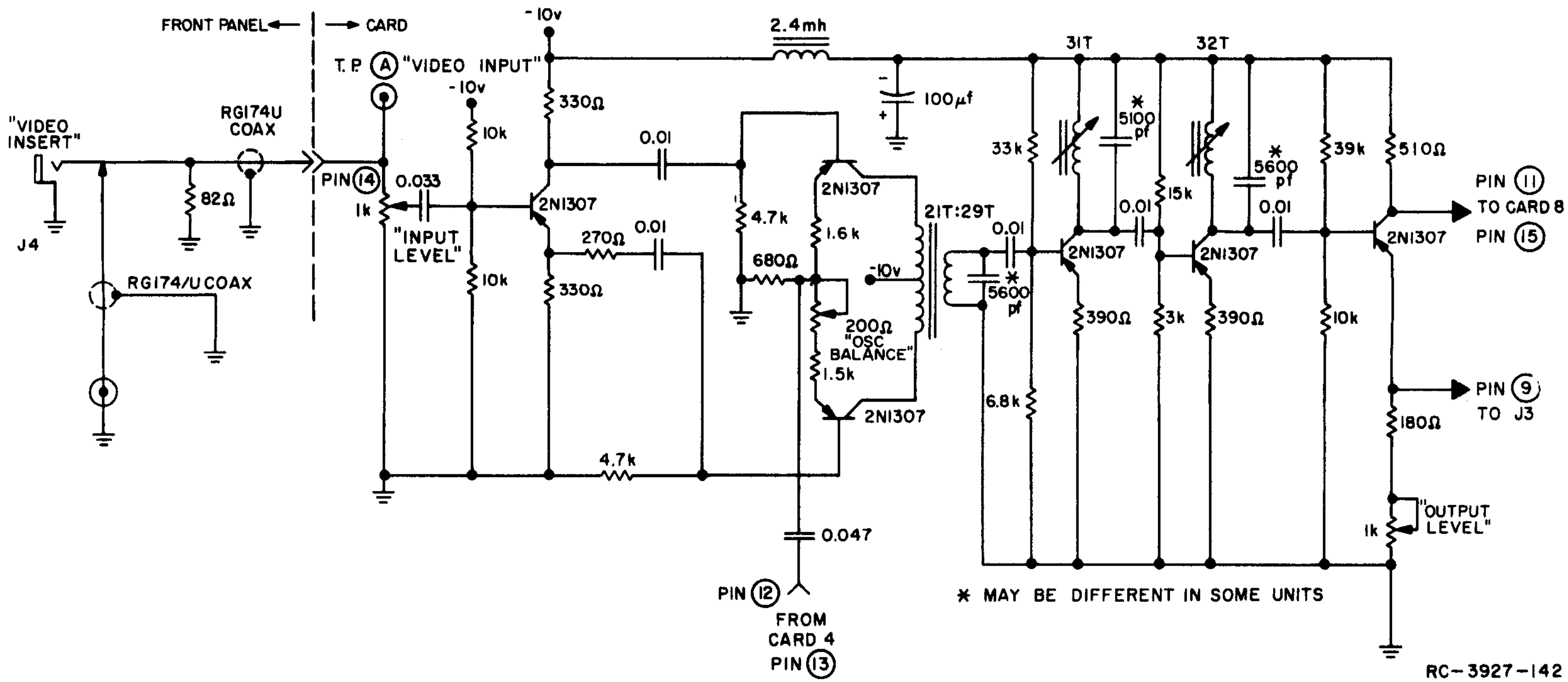
AVCS CARD 2—GATE I, GATE II, AND GATE III



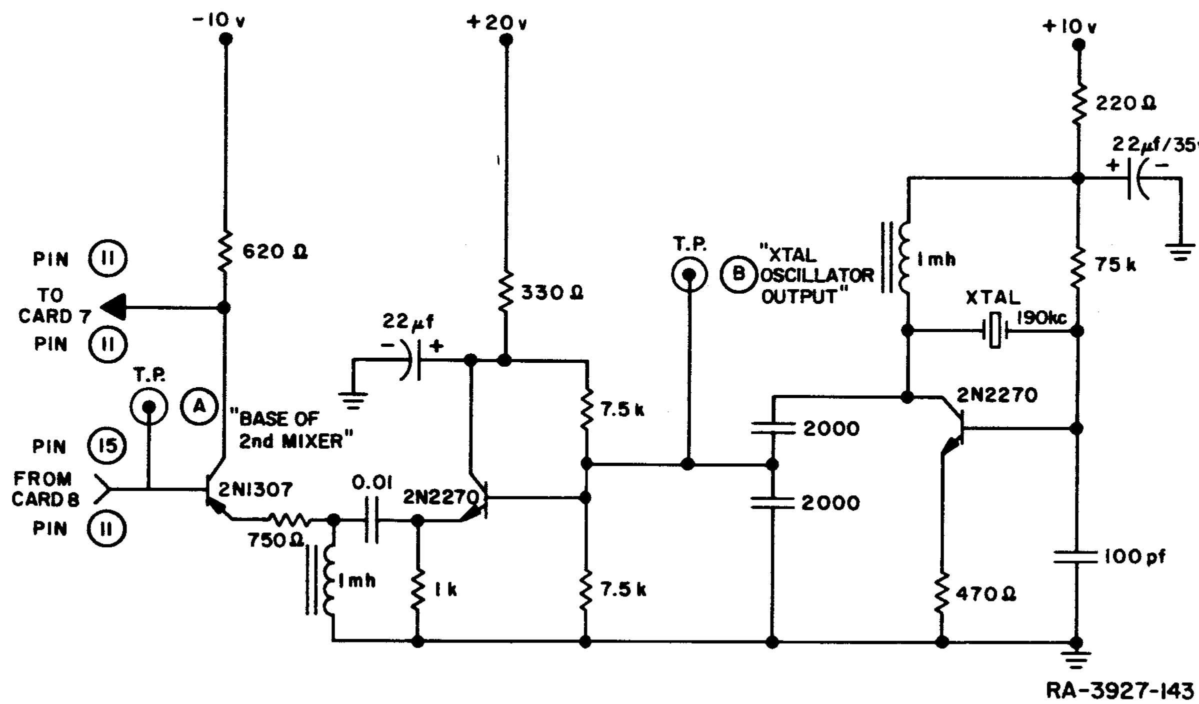
AVCS CARD 3 — LIMITER, DISCRIMINATOR II, AND DISCRIMINATOR III



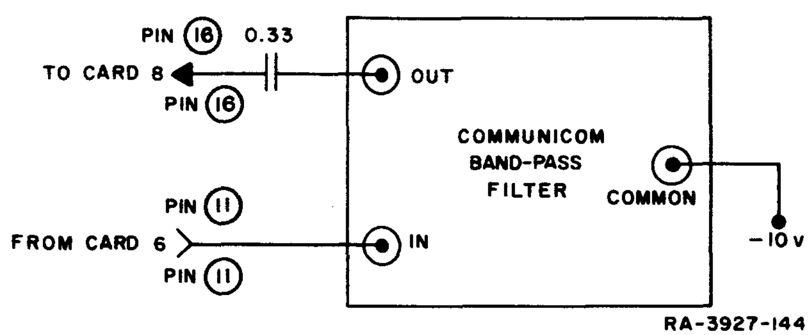
AVCS CARD 4 — CONTROLLED OSCILLATOR, RC FILTER, AND DISCRIMINATOR I



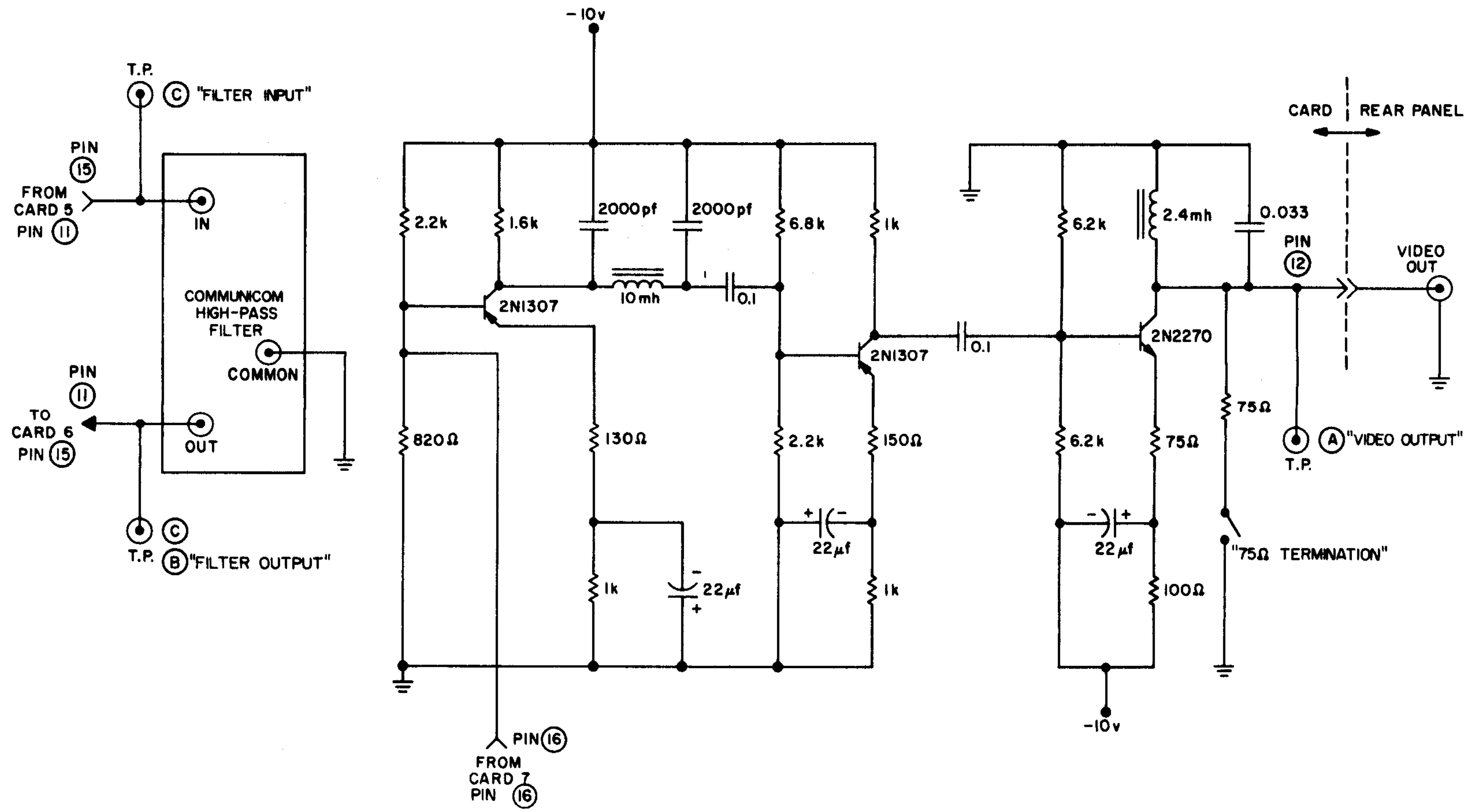
AVCS CARD 5 — PHASE SPLITTER, BALANCED MIXER, AND TRIPLE FILTER



AVCS CARD 6 — 2nd MIXER AND CRYSTAL OSCILLATOR



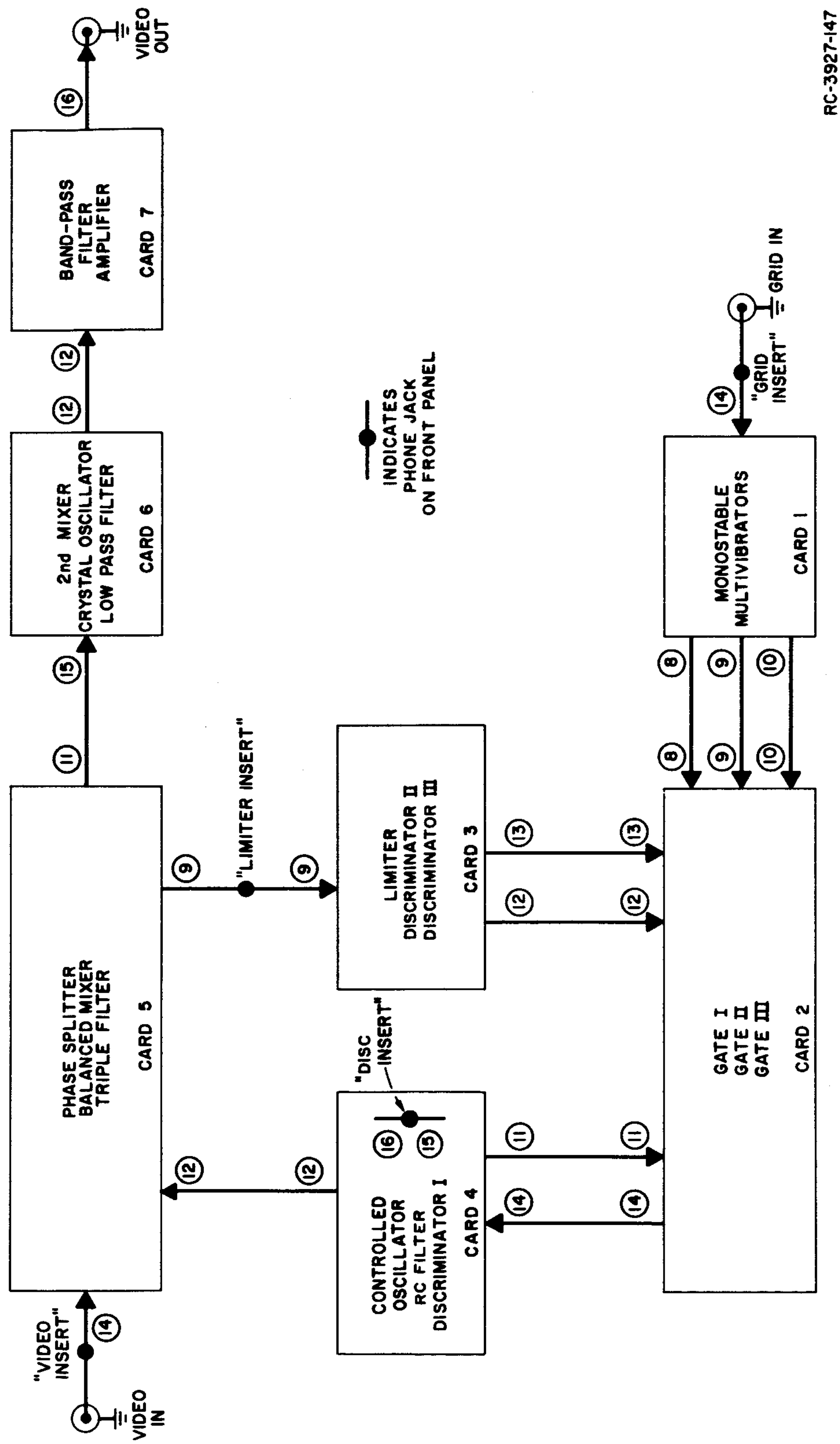
AVCS CARD 7—BAND-PASS FILTER



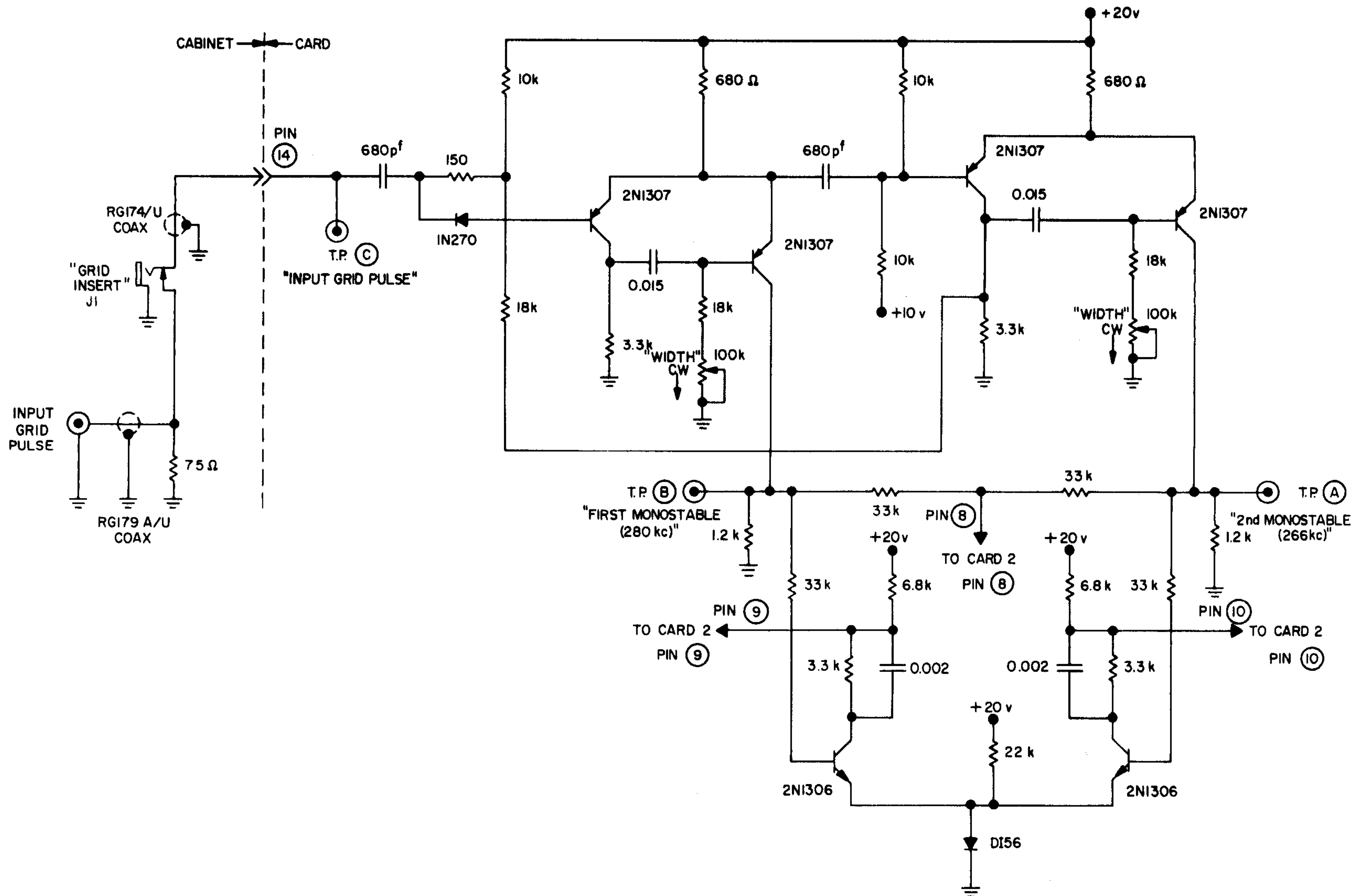
AVCS CARD 8 — HIGH-PASS FILTER AND OUTPUT AMPLIFIER

APPENDIX D

BLOCK AND SCHEMATIC DIAGRAMS OF THE HRIR UNIT



HRIR BLOCK DIAGRAM ACCORDING TO CARD LOCATION



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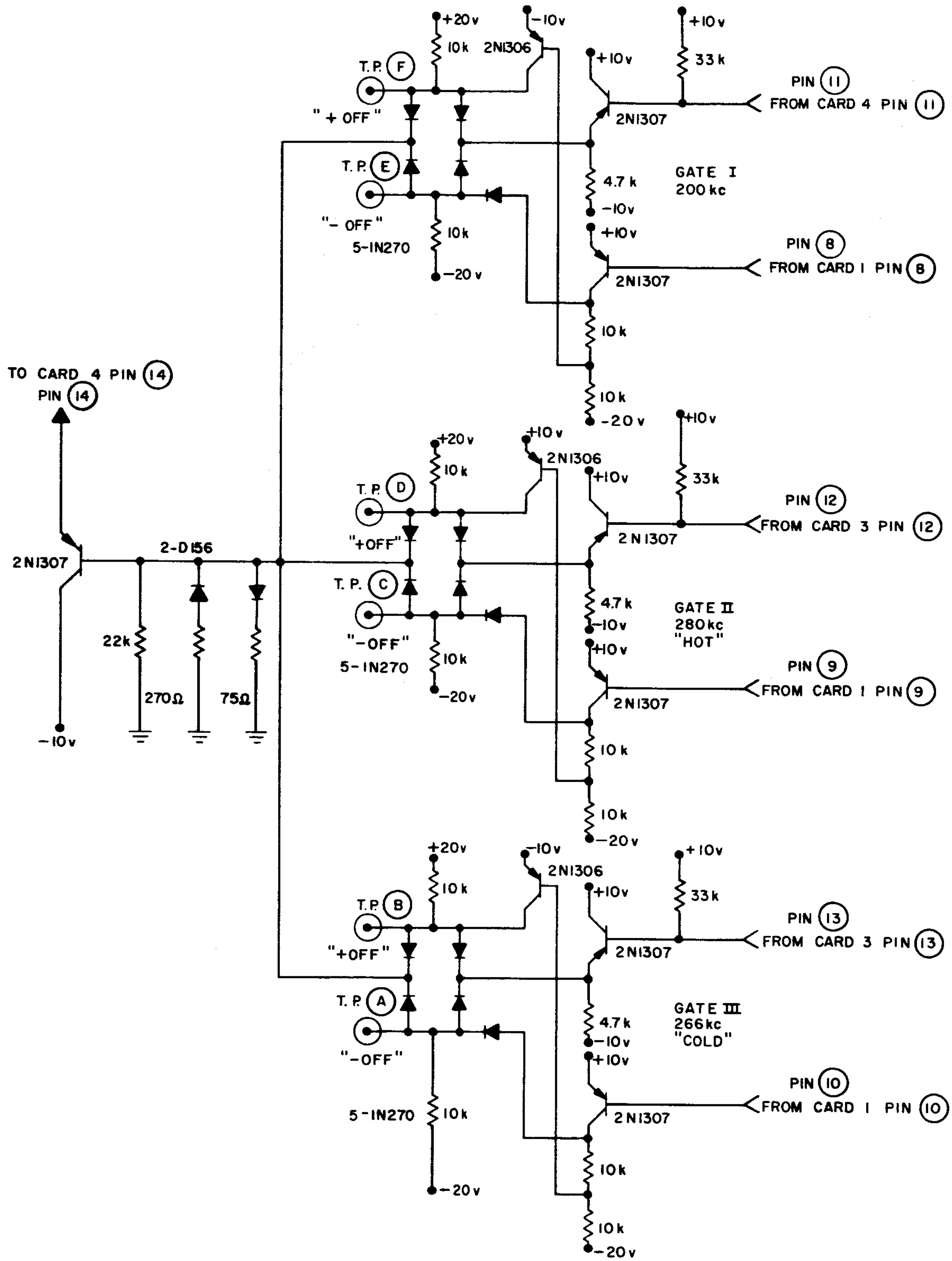
HRIR CARD I — MONOSTABLE MULTIVIBRATORS



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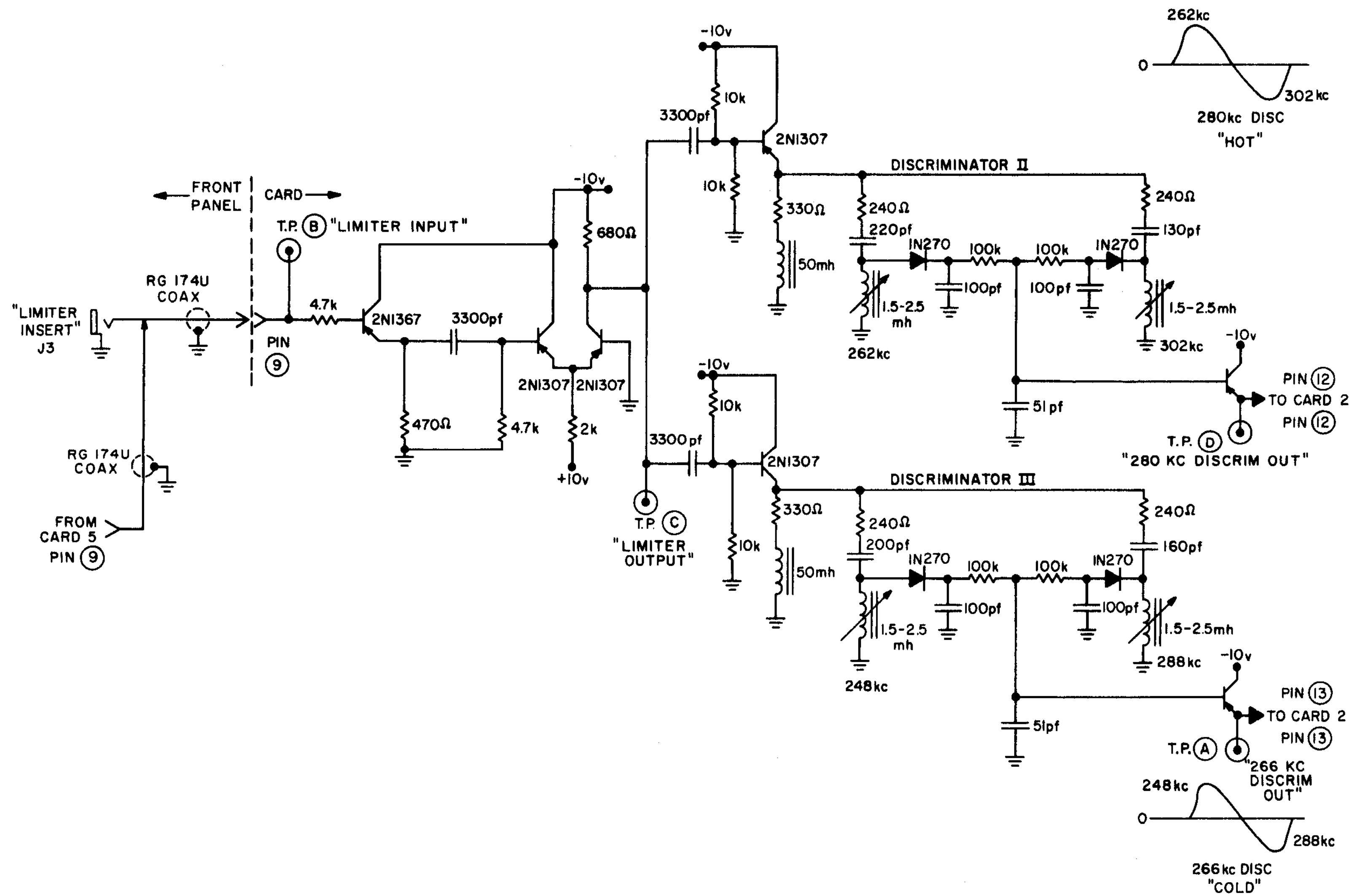
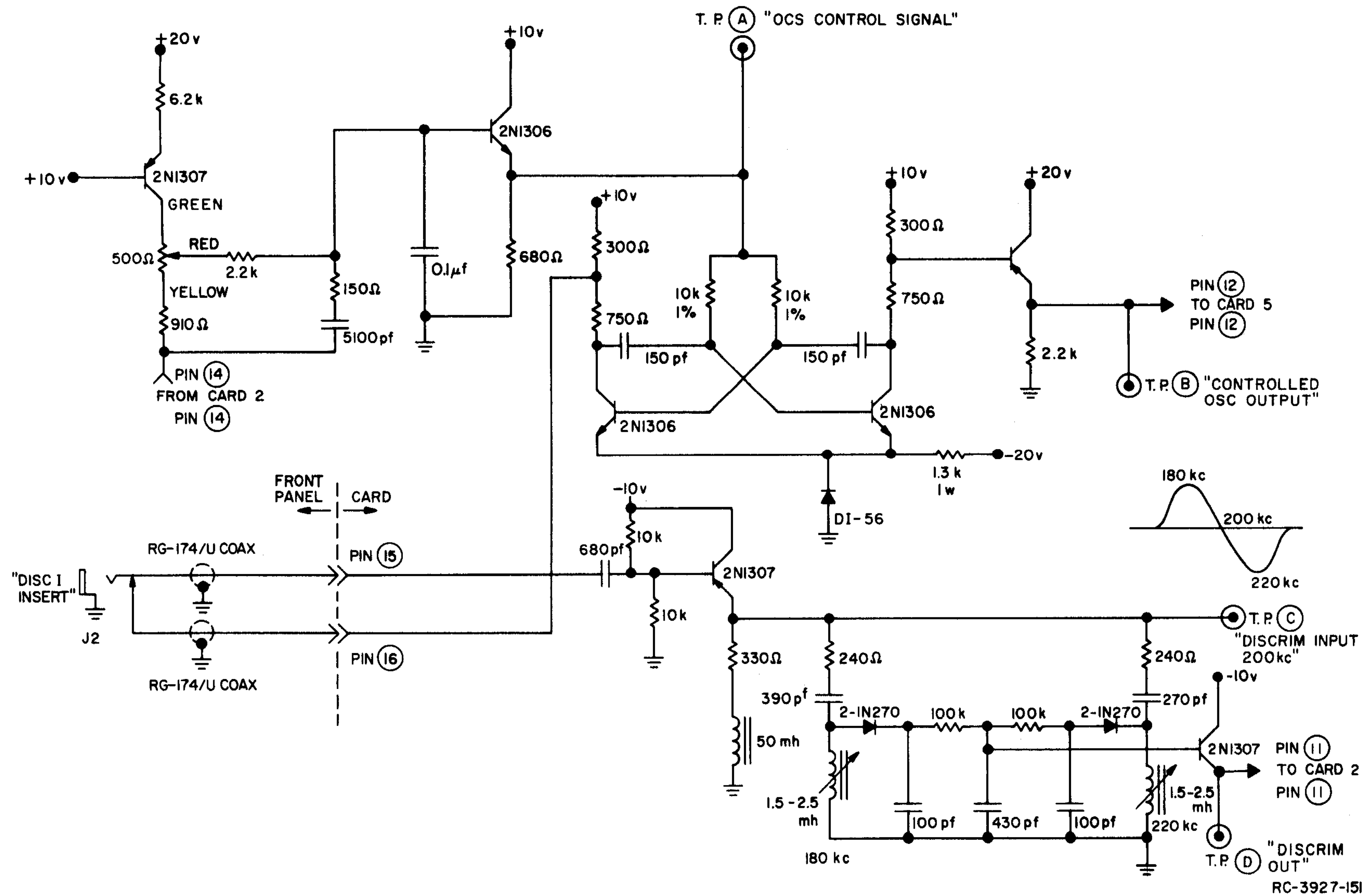
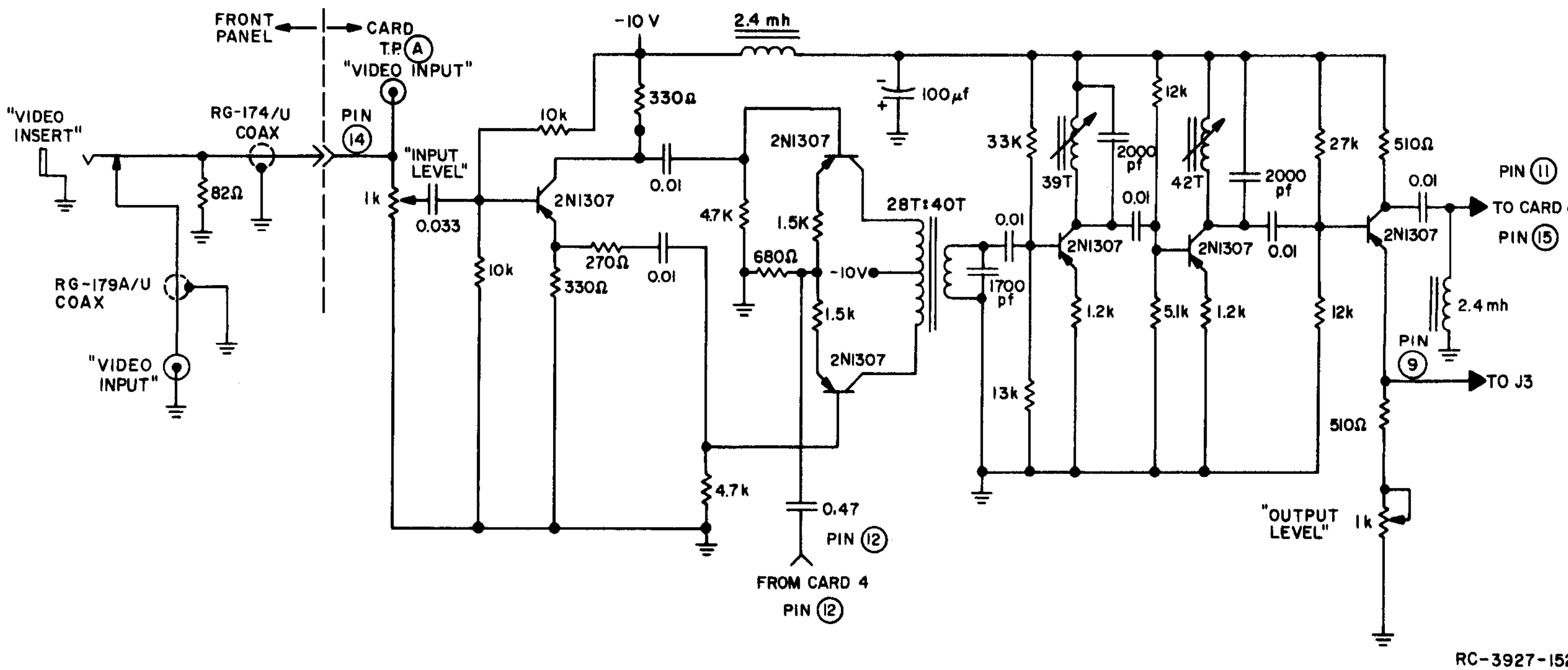
HRIR CARD 2 — GATE I, GATE II, AND GATE III



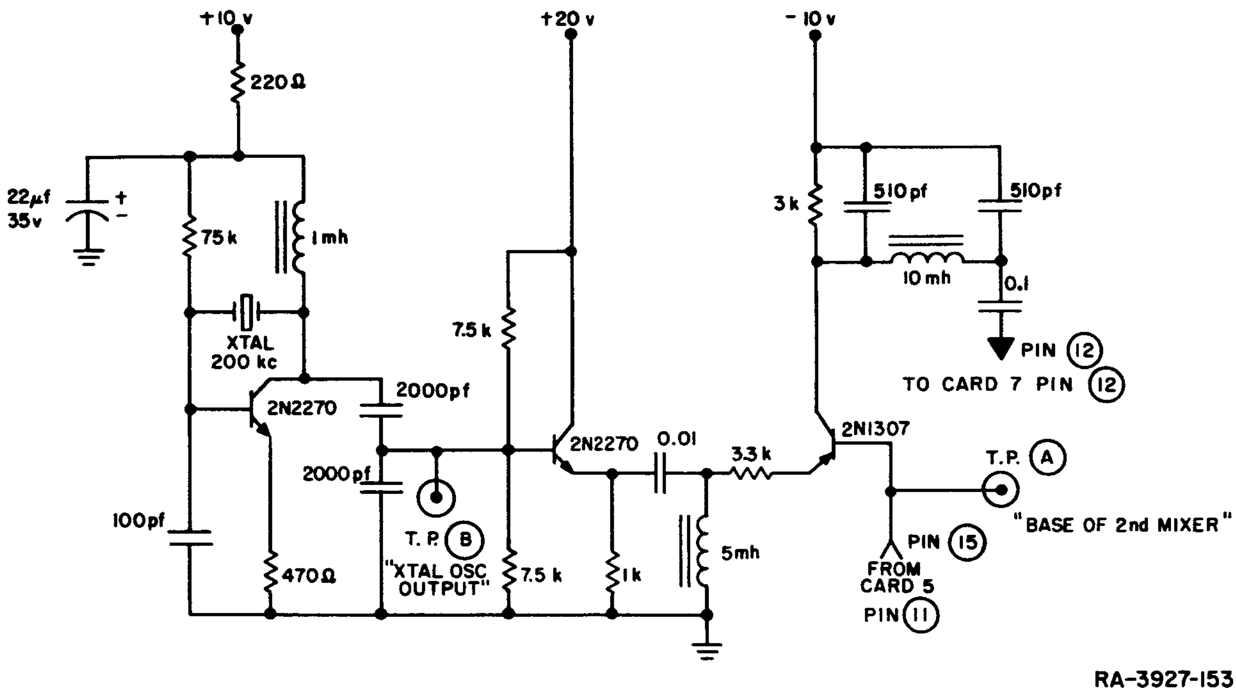
HRIR CARD 3 — LIMITER, DISCRIMINATOR II, AND DISCRIMINATOR III



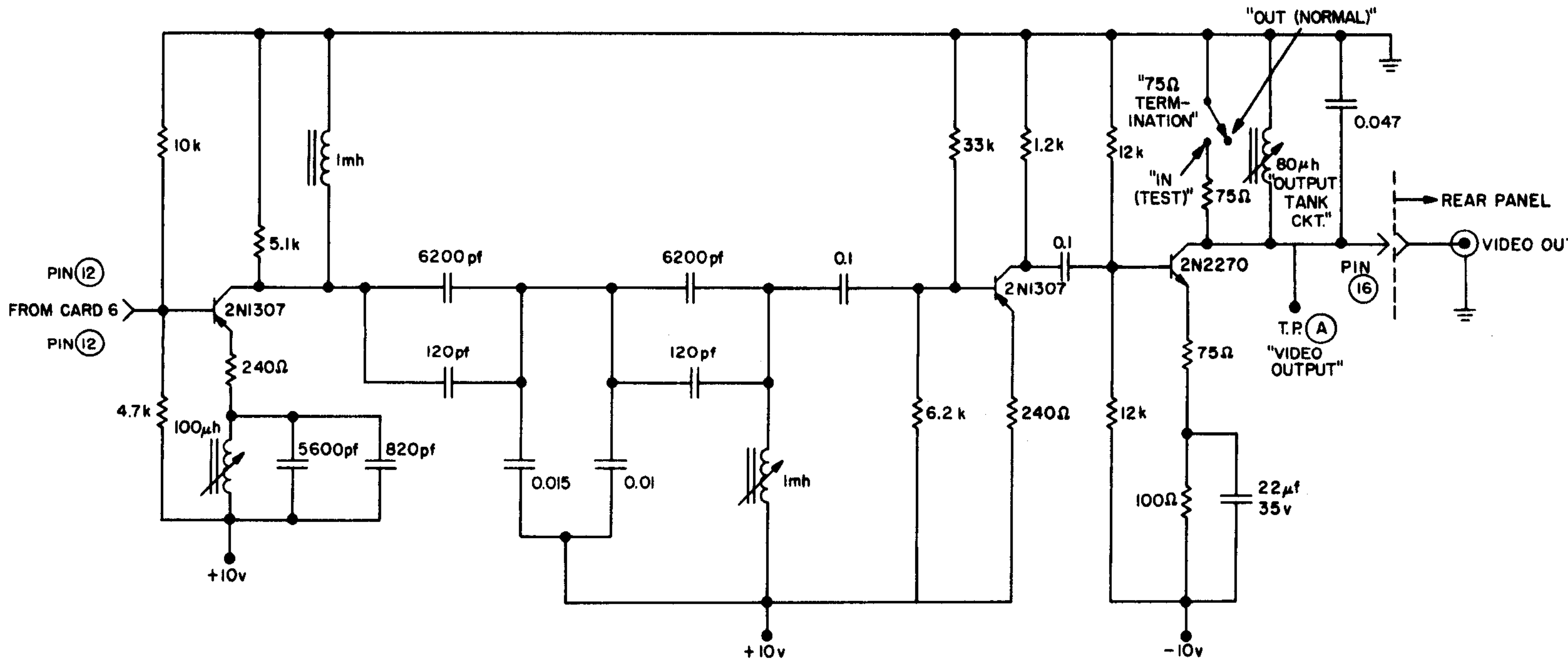
HRIR CARD 4 — CONTROLLED OSCILLATOR, RC FILTER, AND DISCRIMINATOR I



HRIR CARD 5 — PHASE SPLITTER, BALANCED MIXER, AND TRIPLE FILTER



HRIR CARD 6 — 2nd MIXER, CRYSTAL OSCILLATOR, AND LOW-PASS FILTER



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HRIR CARD 7 — BAND-PASS FILTER AND OUTPUT AMPLIFIER

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